STATE OF NEW YORK

DEPARTMENT OF CONSERVATION

WATER POWER AND CONTROL COMMISSION

THE GROUND-WATER RESOURCES OF COLUMBIA COUNTY, NEW YORK

By

THEODORE ARNOW

Geologist, U. S. Geological Survey

Prepared by the

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THE GROUND-WATER RESOURCES OF COLUMBIA COUNTY, NEW YORK

By THEODORE ARNOW

ABSTRACT

This report was prepared as part of a state-wide survey of the ground-water resources of New York being made by the United States Geological Survey in cooperation with the New York Water Power and Control Commission. The field work that forms the basis of the report was done intermittently from 1945 through 1947. Records were obtained for more than 1,000 wells and springs, and 25 water samples were collected and analyzed for chemical content. In addition, the geology of the area was studied, specific attention being paid to the water-bearing properties of the different aquifers.

Columbia County is in the central part of the east side of New York State, and is bounded on the east by Massachusetts and on the west by the Hudson River. It has an area of 638 square miles and in 1950 had a population of 43,262. The western part of the County is in the Hudson lowlands, but eastward, as the altitude increases, the land becomes more rugged. The eastern part of the County is a part of the Taconic Mountains. The climate is temperate. At Chatham the mean annual temperature is 47° F., and annual precipitation averages 38 inches for the period of record.

The geology of the western part of Columbia County has been studied to a considerable extent. Less is known about the eastern part of the County. Almost the entire County is underlain by shale, the notable exception being the Harlem Valley in the eastern part of the area which is underlain by the Stockbridge limestone. The rocks were folded and overthrust toward the west during the Taconic and Appalachian periods of orogeny and those in the eastern part of the County were subjected to different degrees of metamorphism. Throughout the County the bedrock is mantled by a series of unconsolidated glacial deposits. These deposits vary in thickness attaining a maximum of 275 feet in the western part of the County.

Essentially all the ground water in Columbia County has its source in the precipitation on the immediate area. The chief aquifers are the beds of shale. Ground water is recovered almost exclusively by means of wells drilled in rock but the glacial overburden, if properly tapped, will yield much larger quantities. The average yield to wells from bedrock is about 6 gallons per minute, and several public-supply wells, developed in glacial sand and gravel, yield about 100 gallons a minute.

Most of the wells in Columbia County are used for domestic or farm supply, and daily consumption averages less than 500 gallons. There is little industrial development in the County, most of it being in areas where water can be obtained from municipal water systems. Of the 10 public supplies in the County, 5 use ground water. The largest of these, at Chatham, distributes about 350,000 gallons per day.

The chemical quality of water was found satisfactory for most uses in nearly all analyses made for ground water in Columbia County. Water obtained from the unconsolidated deposits in the County is generally lower in dissolved solids than that obtained from the consolidated rocks. The limestones in Columbia County yield the hardest water and spring water from a given formation tends to be softer than well water from the same formation. The average temperature of water from 33 wells having an average depth of 143 feet is about 49° F. The average temperature of 11 springs is about 51° F.

Appended to the report are the records of 397 wells and selected well logs of 25 wells.

INTRODUCTION

PURPOSE AND SCOPE OF INVESTIGATION

This report is part of a state-wide survey being made by the U. S. Geological Survey, in cooperation with the New York Water Power and Control Commission, to provide information concerning the source, quantity, quality, and related aspects of the ground-water resources of the State of New York. The areas in which ground-water studies have been completed and in which work is now in progress are shown in figure 1. A list of the published reports of the New York Water Power and Control Commission is given at the end of this report. In addition, individual reports on Schenectady, Greene, Seneca, Wayne, Washington, Dutchess, and Saratoga Counties are being prepared.

METHODS OF INVESTIGATION

Field work that forms the basis of this report was done intermittently from 1945 through 1947. Records were obtained for more than 1,000 wells and springs and 25 water samples were collected for chemical analysis. In addition, the rock formations and glacial deposits that are the immediate source of the ground water were studied.

The locations of all wells and springs for which records are given are shown on plate 1. It has not been possible to check in the field the exact location of some of the sites, and these are identified on the map according to information given by the driller, owner, or other persons.

The wells, in general, have been numbered in order from west to east, beginning with Cb 1. The springs have been numbered in a separate series beginning with number Cb 1Sp. Although the prefix "Cb" signifies that the particular well or spring is in Columbia County, its use was considered unnecessary on plate 1, as the plate covers only Columbia County.

As an aid in reporting a well or spring location anywhere in New York State, meridian lines at 15-minute intervals have been lettered consecutively from west to east, beginning with "A" and ending with "Z". Similarly, parallels of latitude have been numbered at 15-minute intervals from north to south, beginning with "1" and ending with "17". The intersections of the coordinates form points from which, by means of distance and direction, the wells and springs can be accurately located. For example, the location of Cb 855 as given in table 6 is 11Y, 7.1S, 3.1E. The intersection of lines 11 and Y at the northwest corner of the Kinderhook quadrangle establishes Cb 855 as being in the Kinderhook quadrangle. The exact location is determined by measuring 7.1 miles south and then 3.1 miles east of the point of intersection of lines 11 and Y.

ACKNOWLEDGMENTS

This report was prepared under the supervision of M. L. Brashears, Jr., District Geologist for the U. S. Geological Survey in New York and New England. The State Geologist of New York and officials of the New York State Science Service generously supplied information and publications that were of great help in interpreting the geology of the area. Appreciation is expressed to the members of the New York State Health Department at Hudson who also provided information and assistance. Among the other State agencies contributing information were the Department of Commerce and the Water Power and Control Commission. Thanks are offered to the many well owners, well drillers, and municipal officials who provided information with which the report could not have been written. The sections on location and culture, topography and drainage, and climate were compiled largely by J. J. Miles. Water samples and well and spring records were collected by V. H. Rockefeller, H. N. Halberg, and W. S. Winslow, and the samples were analyzed at the laboratory of the New York State Health Department at Albany, except for one analysis by the Geological Survey at Washington, D. C.

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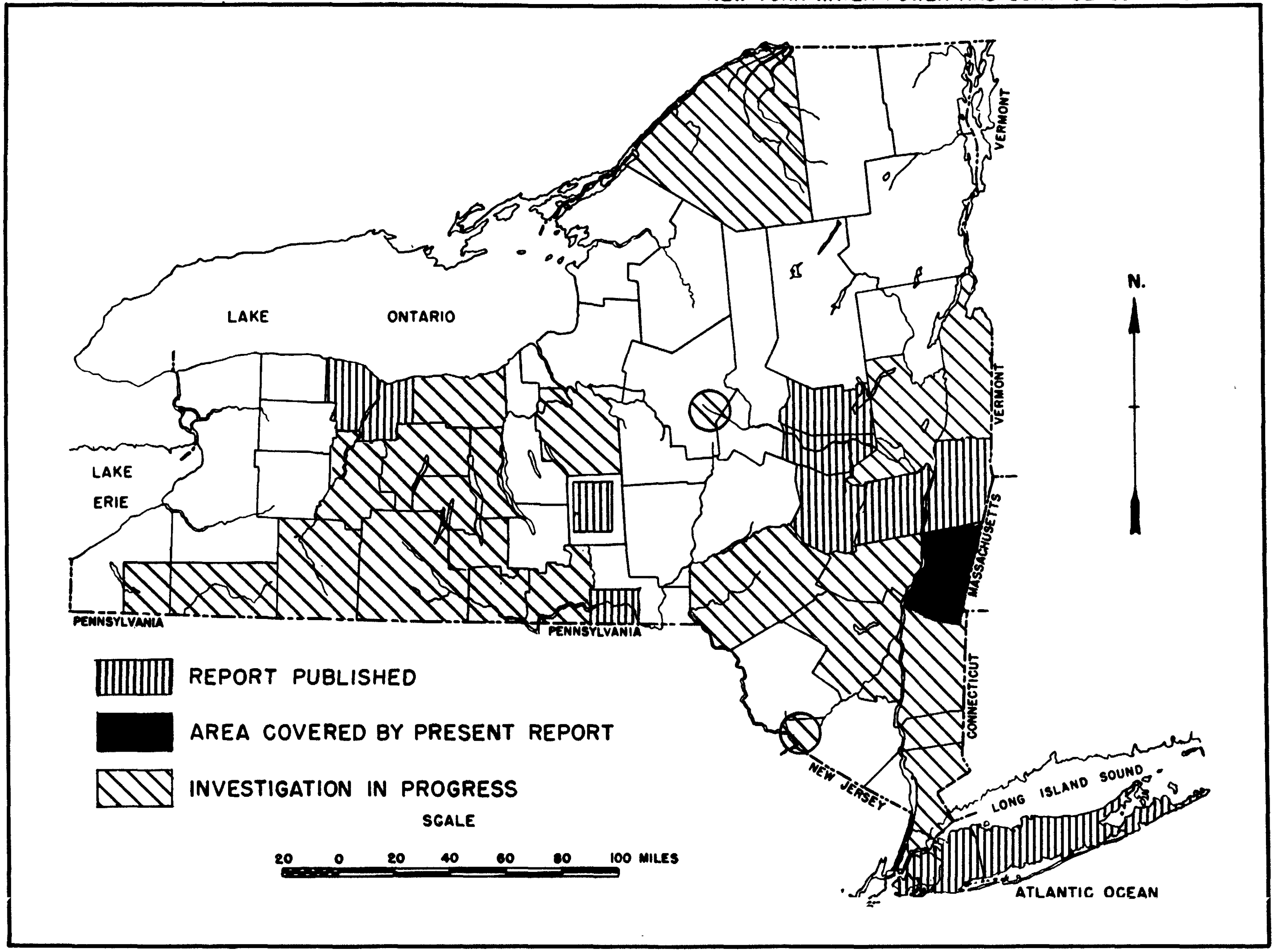

Figure 1.—Index map of New York State showing areas of cooperative ground-water studies.

GEOGRAPHY

LOCATION AND CULTURE

Columbia County is in the central part along the east margin of the State of New York. Its southern boundary is about 100 miles north of the city of New York, its western boundary is the Hudson River, and its eastern boundary, the State of Massachusetts. The County has an area of 638 square miles, or 408,320 acres, and is roughly rectangular, having an east-west dimension of approximately 20 miles and a north-south dimension of about 36 miles.

In 1950 the population of Columbia County was 43,262. Of these, 11,656 people were in Hudson, the County seat and the only municipality having a population of more than 2,500. The towns of Valatie, Chatham, Stottsville, and Philmont had populations between 1,000 and 2,500.

Much of the land in Columbia County originally was forested, but agricultural development began early, progressed rapidly, and became of prime importance. In 1939, according to the New York State Department of Commerce, there were 3,263 persons working on 2,153 farms in the County, which produced a total of $6,945,000 worth of crops, dairy products, and livestock. Fruit, particularly apples, amounts to approximately one-third of the total value of all agricultural products.

In 1939 there were 58 manufacturing establishments in the County. These employed 3,091 people who produced products valued at $14,917,000. The chief industries are the manufacture of textiles, paper, and allied products, and the processing of stone, sand, and glass.

With the exception of the more rugged hill country and the mountainous areas, the County is well served by railroads. These are the main line and the Harlem and the Boston and Albany Divisions of the New York Central Railroad and the Rutland Railroad. Ships and barges on the Hudson River serve as freight carriers for the western part of the County and a large volume of freight to Albany and New York City and eastward into Massachusetts is moved by truck.

TOPOGRAPHY AND DRAINAGE

Columbia County includes part of the western section of the Taconic Mountains and part of the eastern section of the Hudson lowland, which is a northern extension of the great Appalachian Valley. The Hudson River is tidal along the entire western boundary of the County and a few acres of tidal marsh and made land are the lowest-lying bottom lands. The bluff that separates the river bottom lands and the Hudson lowland is comparatively steep but is broken in many places. The Hudson lowland itself is a moderately hilly area. The surface, in part, was modified during Pleistocene time by the scattered deposition of glacial material of different thicknesses. The present topography owes its existence to dissection by the Hudson River and its tributaries, and in part to the differences in resistance to erosion offered by the underlying rocks.

The higher-lying area east of the Hudson lowland consists of gently rolling slopes and valleys separated by generally steep and broken uplands. This hilly area extends through the townships of Livingston, Gallatinville, Copake, Hillsdale, Claverack, Austerlitz, Canaan, New Lebanon, Chatham, and Ghent. The altitudes of the hilltops in this area range from 400 to 600 feet along its western edge to 800 to 1,000 feet farther east.

East of the hill section is the Harlem Valley, which owes its existence to the comparatively rapid erosion of the underlying limestone. The valley ranges in width from about 1½ to more than 5 miles and extends from North Hillsdale in a southerly direction through Copake to Ancram toward the southwest, where it becomes narrower. A tributary valley extends from Boston Corners in a northerly direction to form a fork at Copake. The altitude of the valley bottom ranges from 500 to 800 feet above sea level. The lower-lying lands are nearly flat and the up-valley slopes, though occasionally steep, are for the most part gentle and gradual. The valley is bordered on both sides by steep and mountainous lands.

North of Flatbrook and Canaan Center is a double-pronged valley, about half of which extends into Rensselaer County. This lowland, though at a somewhat higher altitude, is very similar to the Harlem Valley and was also formed in an area of comparatively soluble limestone.

The eastern border of the County is near the crest of the Taconic Mountain range. These mountains include the areas of greatest relief in the County and have a maximum altitude of nearly 2,000 feet above sea level.

A small part of the eastern section of the County is drained by the Housatonic River but the remainder is drained by the Hudson River and its tributaries, including the Roeliff Jansen Kill, Kinderhook, and Claverack Creeks.

A stream-gaging station is maintained on Kinderhook Creek at Rossman by the Surface Water Branch of the Geological Survey. Records of the flow of Kinderhook Creek at Rossman are available for the periods 1906-09, 1911-14, and 1928-50. Records of stream flow are published in annual water supply papers entitled, "Surface water supply of the United States." Current measurements are on file at the office of the U. S. Geological Survey, Surface Water Branch, Albany, N. Y.

CLIMATE

Columbia County has a temperate climate that is marked by seasonal extremes of heat and cold. There is a regional variation of temperature and precipitation between the hill section in the eastern part of the County and the valley lands along the Hudson River. Meteorological records collected by the U. S. Weather Bureau are available for the Chatham Station for the period 1900 to 1921 and for Hudson over a 51-year period; also Mount Lebanon and Spencertown for short periods.

The mean annual precipitation at Chatham is 38.11 inches, including an average depth of snowfall of 55 inches. The greatest recorded annual precipitation, 44.23 inches, fell in 1920 and the lowest, 26.50 inches, fell in 1908. At Hudson, the mean annual precipitation is 38.25 inches including 53.8 inches snowfall. The greatest recorded annual precipitation, 76.24 inches, fell in 1855 and the lowest, 25.72 inches, fell in 1846. Short-term records for Mount Lebanon and Spencertown indicate precipitation in the mountains probably is greater than in the valley lands. The greater part of the mean annual precipitation in Columbia County occurs during the summer months, though it is fairly well distributed throughout the year. Most of the snowfall comes during the months of December, January, February, and March.

The mean annual temperature at Chatham is 47° F. February, the coldest month, has a mean temperature of 22° F. and July, the warmest month, has a mean temperature of 71° F. The extremes of temperature during the period from 1900 to 1921 are −24° F. in February 1920, and 103° F. in July 1911. The average date of the last killing frost in the spring at Chatham is May 9, and of the first killing frost in the fall is October 4, giving an average frost-free season of 146 days. The mean annual temperature at Hudson is 48.2° F. January, the coldest month, has a mean temperature of 24.7° F. and July, the warmest month, has a mean temperature of 71.6° F. Frost data for 25 years of record through 1930 indicates the average date of the last killing frost in the spring is April 29, and of the first killing frost in the fall is October 11, giving an average frost-free season of 163 days. Variations of temperature are believed to be greater in the mountainous areas. Thus, the frost-free period is slightly longer along the Hudson River valley than at Chatham and slightly shorter in the mountainous part of the County.

GEOLOGY AND WATER-BEARING PROPERTIES OF THE ROCKS

GENERAL GEOLOGY

Recent detailed geologic reports have covered only the western part of Columbia County (Goldring, 1943; Ruedemann, 1942b.),[1] and information about the rocks of the eastern section of necessity has been obtained from the more generalized reports that were written about the turn of the century (Walcott, 1888; Dale, 1904). The stratigraphic terminology employed in the old reports differs considerably from that introduced in the more recent papers and used in the present report.

The stratigraphic column for Columbia County is given in table 1, and plate 2 shows the bedrock geology of the County. Much of the stratigraphy has been adapted for the requirements of this report. The Schodack formation has been shown as a separate unit on plate 2 only in the westernmost part of the County, after maps by Goldring and Ruedemann. East of the area covered by these maps the Schodack and Nassau formations are shown by the pattern for the Nassau. Included with the Schodack formation, where shown as a unit, are the Burden iron ore and Bomoseen grit of Ruedemann, the Burden conglomerate of Grabau, and the Zion Hill quartzite of Ruedemann (Wilmarth, 1938). The Normanskill shale, as shown includes the Deepkill shale, and the Walloomsac slate. These terms apply to both the metamorphosed and the unmetamorphosed equivalents.

GEOLOGIC HISTORY

Recorded geologic history in Columbia County begins during the Lower Cambrian, about 500,000,000 years ago, when the area was covered by part of the huge Appalachian sea that stretched from Newfoundland to Alabama and was more than 400 miles wide (Ruedemann, 1942a, p. 56). Early writers stated that this large geosyncline was divided into separate north-south troughs by long barrier ridges, and that in each of these troughs an independent sequence of rock materials was deposited. Ulrich and Schuchert (1902, p. 638) described two such troughs, the Chazy trough on the west and the Levis trough on the east, which they suggest persisted throughout Cambrian and Ordovician time. Prindle and Knopf (1932, p. 264) have distinguished still another trough, east of the Chazy and Levis troughs.

Recently, however, it has been suggested that the entire basin was one continuous unit and that deposits of different lithology were laid down simultaneously in different parts of the sea. The deposits differed according to distance from the shore line and type of source material. Ruedemann (1942b, p. 174) has summed up the entire situation by saying, "It would seem that the varying conditions in the geosyncline allow the conclusion that both working hypotheses may be applied at certain times. . . ." For purposes of convenience, the hypothesis of one basin acting as a continuous unit will be followed in this report.

The oldest rock deposits in Columbia County are the Nassau and the Schodack formations of Lower Cambrian age. The Nassau formation is almost entirely barren of fossils and Ruedemann (1942b, p. 176) believes it might possibly be of very late pre-Cambrian age. Occupying a position between the Nassau formation and the Schodack formation in the long inlier southwest of Hudson is a limonite and siderite iron ore named by Ruedemann (1942b, p. 43) the Burden iron ore (fig. 2). This probably was formed in a lagoonal area that existed between the more widespread marine invasions of Schodack and Nassau times. During the remainder of the period, either the land in this area was above water or a series of deposits were laid down that have been subsequently eroded or are now buried beneath a mass of overthrust sediments overthrust toward the west at the close of the Ordovician period. The latter possibility may be supported by the reported log of well Cb 852, which shows shale from 110 to 800 feet and limestone from 800 to 1,008 feet in depth. The limestone might be the Little Falls dolomite or one of the other limestones of Upper Cambrian age. While the rocks previously discussed were being deposited, simultaneous deposition was taking place to the east. The order of events in this area is not completely understood but it is known that of the deposits laid down in the trough, only the Rensselaer graywacke, the Stockbridge limestone, and the Walloomsac slate are now present in Columbia County (pl. 2 and table 1). The Rensselaer graywacke has long been considered of Upper Devonian age but in more recent publications it has been assigned a place in the Cambrian system (Prindle and Knopf, 1932). The latter classification has been followed in this report. The exact age of the Stockbridge limestone has not been determined, but it is believed to range from Lower Cambrian to Trenton time, both inclusive. The Walloomsac slate is of the same age as the Normanskill shale and in this report they are treated as a single unit.

[1] References are listed alphabetically at the end of this report

Table 1.—Geologic formations in Columbia County and their water-bearing properties

Age: System	Age: Series	Geologic formation	Maximum thickness (feet)	Character of material	Water-bearing properties
Quaternary	Recent	Alluvium	35+	Sorted deposits ranging in size from clay to gravel, found in stream valleys.	Sand and gravel is a productive aquifer if properly developed. Average yield from seven wells is 155 gallons per minute and maximum yield reported is 350 gallons per minute. May be subject to stream recharge and, if so, water may have chemical characteristics similar to those of surface water.
Quaternary	Pleistocene	Glacial drift	275+	Till; heterogeneous mixture of unstratified material ranging in size from clay to boulders; in some places grades into sorted material. Outwash; sorted deposits ranging in size from clay to boulders and in many places stratified and cross-bedded.	Yields water readily only to dug wells of large diameter; not utilized extensively as an aquifer. Average yield of a few poorly developed wells is 13 gallons per minute and maximum reported yield is 80 gallons per minute, but potential yield is much greater. Sand and gravel aquifer is most permeable of any in County and locally is recharged from streams. Water fairly soft and low in total mineral content.
Devonian	Middle or Lower Devonian	Onondaga limestone	20	Light-gray crystalline limestone, the upper part of which is very cherty.	Few records of wells available; formations are unimportant as aquifers in County.
		Schoharie grit	200±	Dark-chocolate grit or sandy shale. Forms ledges and is more resistant to weathering than the Esopus shale.	
		Esopus shale	100±	Dark-chocolate grit or sandy shale. Weathers rapidly into small cubical fragments.	
	Lower Devonian	Oriskany sandstone	1±	Calcareous sandstone, containing an abundance of chert. Weathering produces a porous sandstone by leaching out the lime content.	
		Alsen limestone	25	Dark, blue-gray crystalline limestone, which weathers buff and contains black chert seams.	
		Becraft limestone	45	Light-gray crystalline limestone, in places composed almost completely of shells.	
		New Scotland limestone	68	Thin-bedded argillaceous and siliceous rock with variable amounts of lime; very calcareous and thick-bedded in fresh exposures.	
		Coeymans limestone	45	Compact, finely crystalline, generally dark limestone; massive-bedded in the lower part and with the Manlius forms cliffs.	
Silurian		Manlius limestone	55	Compact, finely stratified impure limestone; very hard and resistant and characteristically forms cliffs.	

Table 1.—Geologic formations in Columbia County and their water-bearing properties (Concluded)

Age: System	Age: Series	Geologic formation	Maximum thickness (feet)	Character of material	Water-bearing properties
Ordovician	Middle and Lower Ordovician	Normanskill shale—Walloomsac slate	1,300±	Primarily black and gray shale containing beds of grit and black siliceous, white-weathering chert. Also present locally are beds of limestone, limestone conglomerate, and reddish, purplish, and greenish shale; some small quartzite bands.	Average yield of 207 wells is 6 gallons per minute and maximum reported yield is 100 gallons per minute. Water obtained principally from fractures. This is most extensively used aquifer in County owing to large area of outcrop. Water moderately soft and fairly low in total mineral content.
Cambrian and Ordovician		Stockbridge limestone	Unknown	Medium-grained bluish-white crystalline thin-bedded limestone, or dolomitic limestone which is sometimes massive and weathers a dull blue gray. Joints well developed and some slightly enlarged by solution.	Average yield of 19 wells is 14 gallons per minute and maximum reported yield is 40 gallons per minute. Most productive consolidated aquifer in County. Water hard and fairly high in mineral content.
Cambrian	Lower Cambrian (?)	Rensselaer graywacke*	1,400±	Dark-green tough generally thick-bedded, often calcareous, crystalline granular rock, containing visible quartz or feldspar grains. This rock alternates with thin beds of purplish, reddish, or greenish slate.	Few records of wells available; formations are unimportant as aquifers in County.
	Lower Cambrian	Schodack formation	250±	Thin-bedded limestone or dolomitic limestone in varying alternations with black or greenish shale and calcareous quartz sandstone. Some limestone beds are brecciated within the sandstone or shale to form brecciation pebbles.	Average yield of 24 wells is 5 gallons per minute and maximum reported yield is 15 gallons per minute. Water obtained principally from fractures. Water is somewhat harder and higher in mineral content than that from Nassau formation owing to solution of limestone layers.
		Nassau formation	785+	Alternating reddish and greenish shales and quartzites. The shale is folded and in places metamorphosed to phyllite.	Average yield of 104 wells is 8 gallons per minute and maximum reported yield is 50 gallons per minute. Water obtained principally from fractures. Water is soft and low in mineral content.

* The Rensselaer graywacke is considered to have been deposited at the same time the Schodack and Nassau formations were deposited.

During the Ordovician period the land was once again invaded by the sea and the thick black, graptolite-bearing Deepkill shale and the Normanskill shale were deposited. Outcrops of the Snake Hill formation have not been observed in Columbia County, although this formation is present both to the north and to the south. The emergence of the land at the close of the Ordovician period marked the beginning of the Taconic disturbance, at which time the rocks were strongly folded and thrust toward the west. Figure 2 shows one of the low-angle thrust planes along which the Cambrian formations overrode the younger Ordovician shales to the west. The isolated outcrops of Cambrian formations west of the main body thus are shown to be fold inliers.

The next marine invasion of the area did not occur until late Silurian time when Manlius limestone was deposited. The boundary between the Silurian and Devonian strata is not strongly marked in Columbia County but the Coeymans limestone, directly overlying the Manlius, is considered to be the first of the Devonian deposits. After the Coeymans limestone was deposited the land was subjected to alternate emergence and submergence and the New Scotland limestone, Becraft limestone, Alsen limestone, Oriskany sandstone, Esopus shale, Schoharie grit, and Onondaga limestone all were laid down. The Onondaga limestone is the youngest consolidated rock now present in Columbia County. Probably Upper Devonian and even Carboniferous beds were once deposited there and since have been eroded. This erosional period, which began late in the Paleozoic era has generally continued to the present, except for some local deposition during the Pleistocene, also was responsible for removal of much of the Silurian and Lower and Middle Devonian beds, as the only remaining deposits of such rocks form two small outliers at Mount Ida and Becraft Mountain.

The close of the Paleozoic era was marked by the Appalachian revolution, at which time the rock formations were greatly deformed. The competent Silurian and Devonian limestones were thrown into long open folds whereas the weaker Cambrian and Ordovician shales were complexly folded and contorted. The intensity of metamorphism of the rocks increases from west to east. The western boundary of the metamorphism cannot be sharply defined but it generally is placed along a line running from Gallatinville to Old Chatham, passing just east of Chatham. According to Pepper (1934, p. 186) most of the deformation was caused by the Appalachian rather than Taconic orogeny.

Miller (1924, p. 91) has shown that there were several periods of glaciation during the Pleistocene epoch, but in Columbia County the last ice sheet overrode and removed the sediments deposited by earlier glaciers. The main ice sheet originated in Labrador and from there spread south through Canada to the United States. One of the tongues of ice followed the Champlain-Hudson trough as far south as Long Island and it was this sheet of ice that covered Columbia County. Except for a scraping and plastering process that rounded and smoothed the countryside, the ice invasion wrought no major basic changes in the topography. When the ice eventually retreated or stagnated in place, however, it left behind a great mass of deposits in the form of drumlins, kames, moraines, and stratified water-laid material. These deposits, in varying degrees of thickness, almost completely mantle the County and are of great value with respect to ground-water supplies.

After the disappearance of the ice, the present drainage pattern was established and the modern streams assumed the role of erosion and alluvial deposition that exists today.

GEOLOGY IN RELATION TO GROUND WATER

Nassau Formation

The Nassau formation, as originally described by Dale (1904, p. 29), is a series of five divisions that have an estimated maximum total thickness of 785 feet. Actual separation of the divisions in Columbia County is difficult because the formation has been intensively folded. On the whole, the formation consists of greenish or reddish and greenish shale, interbedded with thin layers of quartzite or grit. In addition there is some massive greenish quartzite. In the area east of Elizaville the formation has been matamorphosed to form a phyllite. According to Dale (p. 17), "The microscopical composition and structure of this shale indicate that it would probably not have required a vastly increased amount of compression to transform it into schist."

The Nassau formation consists of tight, dense rocks which in themselves are practically impervious. They contain many joint, cleavage, and bedding planes, however, and it is through these openings that ground water moves through the formation. Records of 104 wells in the Nassau formation show an average yield of only 9 gallons per minute, and one-quarter of the wells yield less than 3 gallons per minute. The highest reported yield of a well tapping the Nassau formation is 50 gallons per minute (well Cb 818). Such a yield is unusually high, however, and yields of similar

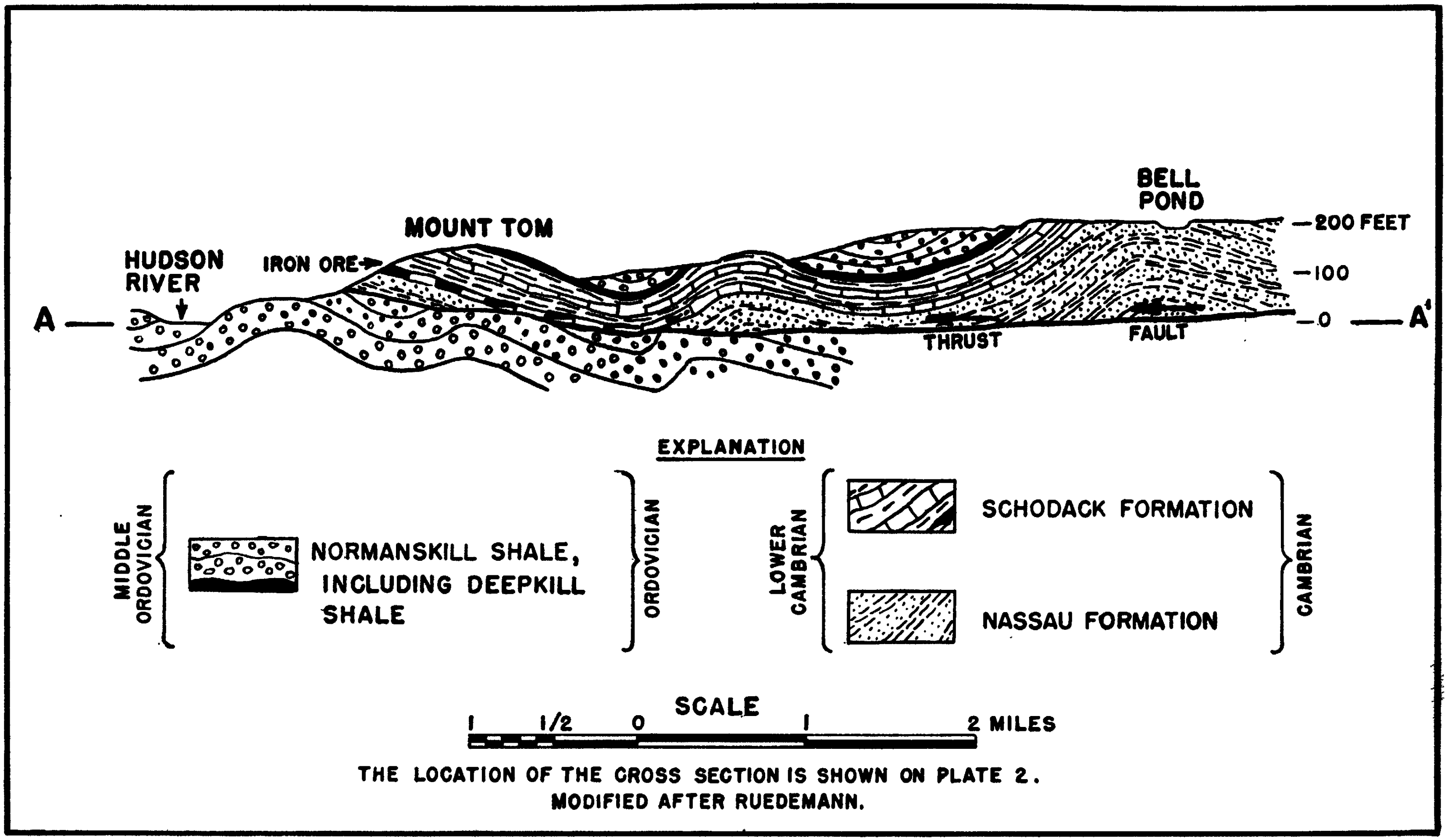

Figure 2.—Diagrammatic east-west section showing relation of Lower Cambrian to Ordovician beds.

magnitude cannot normally be expected. The average thickness of rock penetrated by 106 wells in the Nassau formation is about 90 feet, whereas the average depth of these wells is 125 feet, and the range in depth is from 33 to 520 feet. The average specific capacity of 57 wells tapping the Nassau formation is 1.21 gallons per minute per foot of drawdown. The Nassau beds underlie a large area in the more densely populated western part of the County and consequently are tapped extensively for domestic supplies of ground water.

Schodack Formation

As stated in the section on general geology, the term "Schodack formation" in this report includes the Schodack formation itself, the Burden iron ore and the Bomoseen grit of Ruedemann, the Burden conglomerate of Gubau, and the Zion Hill quartzite of Ruedemann. All except the Schodack are comparatively thin in relation to the whole, have a small areal distribution, and are folded together with the Schodack formation. The Schodack consists of thin-bedded limestone or dolomitic limestone in alternation with black or greenish shale and calcareous quartz sandstone. Some of the beds of limestone are brecciated. The thickness of the Schodack formation in Columbia County has not been definitely ascertained, but it is believed by Ruedemann (1942b, p. 63) to be about 250 feet.

The Schodack formation is similar to the Nassau formation in that it consists of dense, impermeable rocks that transmit water only through joint, cleavage, and bedding planes. Records of 29 wells that tap the Schodack have an average yield of 5 gallons per minute, and only 1 of these wells yields over 15 gallons per minute. The average thickness of rock penetrated by the 29 wells is 79 feet whereas the average depth of these wells is 147 feet, and the range in depth is from 75 to 352 feet. The average specific capacity of 10 wells in the Schodack formation is 0.18 gallon per minute per foot of drawdown. Although yields from the Schodack are small, they are sufficient to meet normal domestic demands, and consequently the formation is tapped extensively.

Rensselaer Graywacke

The only outcrop of the Rensselaer graywacke in Columbia County is a small outlier in the northern part of the County (pl. 2). The thickness of the outlier is not known but it is believed by Dale (p. 43) to approximate the 1,400 feet assigned to the main body of the Rensselaer graywacke plateau that lies north of Columbia County. The graywacke is a dark-green metamorphic grit that is generally thick-bedded crystalline and calcareous. The grit is interbedded with purplish, reddish, or greenish shale or slate, and an occasional thin bed of conglomerate. Similar to the Nassau and the Schodack formations, the Rensselaer graywacke consists of dense, impermeable rocks that transmit water only through joint, cleavage, and bedding planes. Data for only two wells that tap the Rensselaer graywacke, Cb 174 and 175, have been obtained. These have a yield of less than 5 gallons per minute. Primarily because of its small area of outcrop, and partly because of its low yield, the Rensselaer graywacke is of minor importance as a source of ground water in Columbia County.

Stockbridge Limestone

The Stockbridge limestone crops out only in the valleys in the eastern part of the County. It consists of a medium-grained hard bluish-white crystalline thin-bedded limestone or dolomitic limestone, which is sometimes massive and which weathers a dull gray. The Stockbridge limestone has been metamorphosed so that at some sites it is in the form of marble. The rock is dense and impermeable and transmits water only through bedding, cleavage, and joint planes. Records of 20 wells show an average yield of 11 gallons per minute and an average rock penetration of 66 feet, whereas the average total depth of the wells is 126 feet. They range in depth from 32 to 323 feet. The average specific capacity of six wells tapping the Stockbridge limestone is 0.49 gallon per minute per foot of drawdown. The Stockbridge is extensively tapped in the relatively small area that it underlies. Owing to the metamorphism that it has undergone and its extreme hardness, the Stockbridge limestone is a difficult formation in which to drill.

Normanskill Shale

Although termed a shale, the Normanskill is diversified in nature and contains many different facies. It is primarily a black or gray shale with interbedded layers of grit and black siliceous white-weathering chert. It also contains some thin beds of limestone, calcareous conglomerate, and reddish, purplish, or greenish shale. The thickness of the Normanskill shale in Columbia County has not been determined but, including the Deepkill shale, it is estimated by Ruedemann (1930, pp. 17, 88) to be about 1,300 feet. The shale has been subjected to much folding and contortion, and

in the eastern part of the County has undergone different degrees of metamorphism. The Normanskill shale is similar to other consolidated formations in Columbia County in that it consists of dense, impervious rocks that transmit ground water only through fractures and cleavage and bedding planes. Records of 207 wells tapping the Normanskill show an average yield of 8 gallons per minute and an average rock penetration of about 95 feet. The average total depth of the 207 wells is 149 feet and they range in depth from 30 to 1,056 feet. The yield of wells apparently is not related to the degree of metamorphism. The highest reported yield from the Normanskill is 100 gallons per minute, but this appears unusually high, and yields of such magnitude normally are not to be expected. The average specific capacity of 106 wells tapping the Normanskill shale is 0.26 gallon per minute per foot of drawdown. The Normanskill underlies a large area in Columbia County (pl. 2). In the northeast the Walloomsac slate is mapped with the Normanskill shale. Because this formation underlies a large area it has been extensively tapped for supplies of ground water.

Silurian and Devonian Formations

The Silurian and Devonian formations in Columbia County are confined to a small outlier at Mount Ida and a larger one at Becraft Mountain (pl. 2). At Mount Ida the Manlius limestone (Silurian) and the Coeymans limestone (Devonian) are present. In addition to these, the Devonian rocks at Becraft Mountain include the New Scotland limestone, the Becraft limestone, the Alsen limestone, the Oriskany sandstone, the Esopus shale, the Schoharie grit, and the Onondaga limestone. The Manlius limestone lies with a distinct angular unconformity upon the older rocks, and whereas the latter are severely distorted and folded, the rocks of the outliers have merely been pressed into broad open folds. These rocks are described in table 1. They are all compact impervious rocks that yield water only through joint, cleavage, and bedding planes. The two areas of outcrop are mountainous in nature and are thinly populated. Records have been obtained of only two wells in the Becraft outlier and from one of these, Cb 858, a yield of 10 gallons per minute is reported. This well passes through the New Scotland limestone and the Coeymans limestone and ends in the Manlius limestone. The Silurian and Devonian rocks in Columbia County are of minor importance as sources of ground water.

Glacial Deposits

The glacial deposits, except in a few small areas, completely mantle the entire region and are the major source of large supplies of ground water in Columbia County. They may be divided into two major groups, till and outwash (fig. 3). Till is a heterogeneous mixture of particles ranging in size from clay to boulders. It consists of earth debris picked up by ice sheets and deposited later as the glaciers move forward or recede. It may assume the form of ground moraine, which is a relatively thin, widespread layer of till; drumlins, which are elongated hills; and lateral or end moraines, which are masses of till deposited at the sides or forward end of a glacier. All these forms are found in Columbia County, but as they are composed of the same basic materials and have similar physical characteristics they are treated as one water-bearing unit. Till is relatively impervious and yields supplies of water that generally are sufficient only for household or general farm use. Water is best obtained from till by means of large-diameter dug wells that offer a large infiltration and storage area, and are comparatively inexpensive to construct. Although the rate of inflow into a well dug in till is small, it generally is ample to meet the small requirements. Wells of this type are constructed only where small amounts of water are required, and where the underlying bedrock is such a poor aquifer that the cost of drilling a deep rock well would be too great to fit the economic need.

Outwash consists of sorted material that has been deposited directly by glacial streams, has resulted from the reworking of unsorted deposits by glacial streams, or has been deposited in standing water of glacial origin. Outwash deposits laid down by streams emanating from glaciers differ in lithologic properties because the velocity, volume, and load of the streams themselves differed according to the rate of melting of the ice. The deposits are generally cross-bedded and show marked gradations in size, ranging from silt through coarse gravel and occasional boulders. In addition, outwash is found overlain, underlain, or intermingled with till deposits. The outwash areas may exist as lenses in the surrounding till, and there generally is no sharp dividing line between the two types of material. The beds of coarser outwash may yield large supplies of ground water, depending upon the conditions of recharge. The third type of outwash deposit consists of materials that were laid down in standing waters of glacial origin. They generally are well sorted and consist of relatively fine materials such as sand, silt, or clay. The origin of these deposits in Columbia County is not fully understood. According to Woodworth (1905, p. 175), the deposits were laid down in one large lake, termed Lake Albany, which occupied the Hudson Valley during the retreat of the last glacier. Cook (1930, p. 196), however, believes that rather than one large lake, there existed a series of smaller lakes created by temporary barriers during the stagnation of the ice in

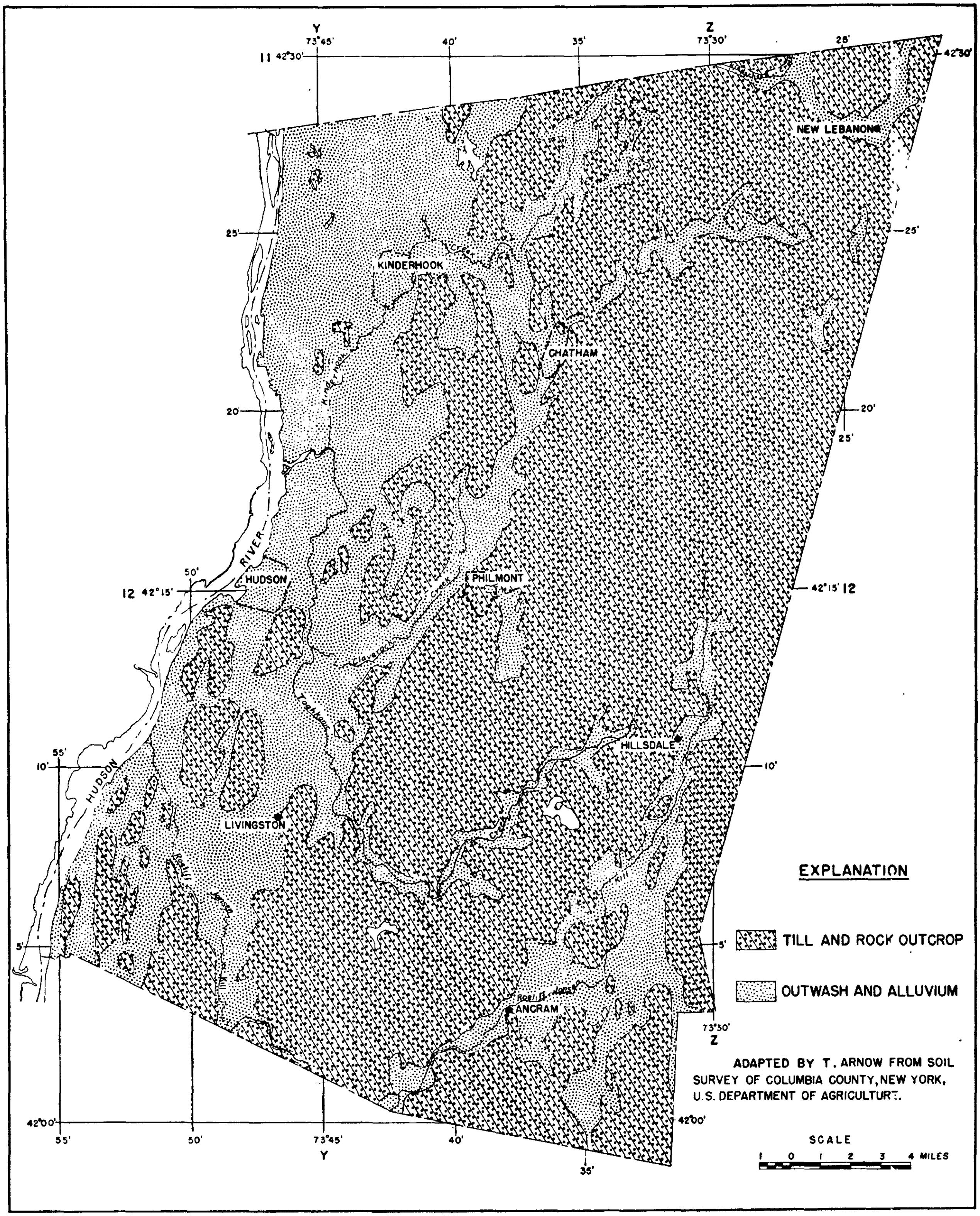

Figure 3.—Approximate areal distribution of till and outwash deposits, Columbia County, N. Y.

place, and the clay and fine sand accumulated to various summit levels in these lakes. In Columbia County the upper level of the clay deposits in the Hudson Valley is about 215 feet above sea level (Cook, 1942, p. 201). Clay deposits are found at much higher levels in the valleys of the mountainous areas to the east, however, where individual lakes were created by short-lived ice or debris blockades.

The clay is even more impervious than the till and no records are available for wells in Columbia County that obtain water from the clay. The sand of lacustrine origin, though very fine in texture, is much more pervious than the clay. The sand yields water readily to dug wells and also, in sufficient quantities for household use, to driven wells. Records are available of 12 driven wells, all 1¼ to 2 inches in diameter and averaging 17 feet in depth. Data from 5 of the wells show an average yield of 6 gallons per minute.

The coarser stream-laid glacial deposits are potentially one of the most productive aquifers in the County. Data are available of only 44 drilled wells tapping sand or gravel deposits, however, and these show an average yield of 13 gallons per minute and a maximum yield of 80 gallons per minute. Six of the wells have been screened or gravel-packed or both, whereas the others have not been developed at all and draw their water supply directly through the open end of the casing which rests in the water-bearing bed. The failure to tap the outwash deposits and to develop the wells properly will be discussed further in the section on recovery.

The thickness of the glacial deposits in Columbia County is irregular and attains a recorded maximum of 275 feet at well Cb 157. Relatively thick deposits are found in places throughout the County; plate 3 shows the locations of wells which have penetrated 100 feet or more of drift. The extensive deposits in the western part of the County are primarily fine-grained, having been laid down in standing waters of glacial origin. (See table 5, logs of wells Cb 68, Cb 90, Cb 218, Cb 219, Cb 598, and Cb 852.) These logs indicate, however, that layers of coarser material are often found associated with the finger deposits, and that in many places a layer of gravel lies between the finer-grained material and the underlying rock. These gravel layers generally constitute excellent aquifers. Lake deposits also are found in the eastern part of the County, but there they generally are confined to the valley areas (table 5, log of well Cb 741). The uplands are more likely to have deposits of till (logs of wells Cb 665 and 698).

Cook (1942, p. 26) has suggested that the Roeliff Jansen Kill (or some other contemporaneous stream) prior to glaciation flowed northwest from Blue Stores. A contour map of the bedrock surface of the area (pl. 3), based on well data, indicates that such a channel does exist and that it is now concealed by a heavy blanket of drift. Another buried valley, as outlined by the 100-foot contour line, extends north from Blue Stores and coalesces with the present course of Taghkanic Creek.

The mouth of another buried valley that once carried a tributary of the Hudson River is outlined by the 0 and minus 100-foot contour lines southwest of Kinderhook. The valley turns toward the northeast, along the path of the present-day Stuyvesant Brook, and is outlined by the 100- and 200-foot contour lines almost to the County border. The existence of such buried valleys is of considerable importance because of the possibility of their containing extensive deposits of highly permeable materials, and it is an important factor to evaluate when planning the location of a new ground-water supply. If the deposits in the buried valleys, or permeable glacial deposits other than in the buried valleys, are near present streams or lakes they may be subject to infiltration of surface water. Under such circumstances it will be possible to obtain large quantities of water from these deposits.

Alluvial Deposits

The youngest deposits in Columbia County are the Recent alluvial clays, silts, sands, and gravels associated with the larger streams. The maximum thickness of these deposits is not known but at well Cb 855 of the Kinderhook public supply system in the Kinderhook Valley, the alluvium is at least 35 feet thick. A pumping test of Cb 855, a 6-inch screened well 35 feet in depth, showed a 1.5-foot drawdown after 8 hours of pumping at 110 gallons per minute. A similar test of Cb 856, an 8-inch screened and gravel-packed well 32 feet deep also part of the Kinderhook supply, showed a 7.5-foot drawdown after 6 hours of pumping at 220 gallons per minute. Wells Cb 862, 869, and 870, which provide part of the Valatie public supply, obtain 100, 75, and 150 gallons per minute, respectively, from the alluvium. Cb 865, a combination dug well and infiltration gallery, originally obtained 350 gallons per minute from the alluvium, but owing to silting the yield from this well has decreased to about 100 gallons per minute.

Alluvial deposits are subject to recharge from nearby streams and consequently can furnish large quantities of water, if properly developed by modern, efficient wells or an infiltration gallery specifically designed to draw water from the particular formation encountered.

GROUND WATER

SOURCE AND OCCURRENCE

Ground water has been defined by Meinzer (1923a, p. 38) as "that part of the subsurface water which is in the zone of saturation," and it is commonly thought of as the water that is obtained from wells and springs. Although it issues from the ground, its source is in the atmosphere; it is estimated that at least 99 percent of all ground water in Columbia County is derived from the rain and snow that falls on the immediate area. An inch of rain is equal to more than 17 million gallons of water per square mile. Multiplying this by the average rainfall at Chatham and Hudson of about 38 inches it may be seen that a square mile of land surface in these areas annually receives about 650 million gallons of water. Of the total water falling on Columbia County each year, part runs off directly in the streams, part evaporates or is consumed by plants, and the remainder seeps into the ground and recharges the water table. Although the supply of ground water generally varies directly with the amount of precipitation, other factors also control the rate of recharge, such as the distribution of precipitation and seasonal changes in the amount of water used by vegetation. For example, a heavy rain for a short period of time would favor considerable surface runoff and therefore little recharge to the water table, whereas the same amount of rain falling for a longer period of time would favor less surface runoff and more recharge to the water table. If the temperature is very high and the relative humidity is low, the rate of evaporation increases, thus dissipating much ground water where the water table is at a near low surface. If, on the other hand, the temperature is so low that the ground is frozen, an unusually high percentage of water then runs off directly into the streams. Vegetation uses large amounts of water during the growing season, but after the first killing frost this factor is largely eliminated.

All rocks, regardless of their density, contain some pore spaces. Only those pore spaces that are large enough, however, can supply water to springs and wells tapping the rock. The amount and size of the openings differ according to the physical and chemical characteristics of the rock, and yields are, therefore, related directly to the type of rock penetrated. The percentage of total rock volume that is occupied by pore space determines the *porosity* of the rock. According to Meinzer (1923a, p. 3), the porosity of a sedimentary deposit depends chiefly on (1) the shape and arrangement of its constituent particles, (2) the degree of assortment of its particles, (3) the cementation and compaction to which it has been subjected since its deposition, (4) the removal of minerals through solution by percolating waters, and (5) the fracturing of the rock, resulting in joints and other openings.

Although the porosity of a rock indicates the total volume of pore space available for storing water, it is necessary to use the term *specific yield* to indicate the amount of water that will drain out of a rock because of the action of gravity. The specific yield of a rock or soil, with respect to water, is the ratio, expressed as a percentage, of (1) the volume of water which, after being saturated, it will yield to gravity to (2) its own volume. It is a measure of the water that is free to drain out of a material under natural conditions. The value for the specific yield of a rock or soil is less than the value for porosity, as capillary forces prevent the draining, by gravity, of all the interstices or pore spaces. In addition to specific yield, the term *hydraulic permeability* is used to indicate the capacity of the rock or soil to transmit water under pressure. This term is useful primarily when dealing with uniform, unconsolidated deposits, and should be used cautiously (if at all) when the aquifer is an indurated rock that transmits water only through fracture or solution planes. In general the smaller the interstices of a material the lower its specific yield and hydraulic permeability. Thus, clays and silts, which generally have higher porosities than sands and gravels, yield considerably less water.

The *water table* is an irregular surface of a zone in which, under ordinary conditions, all rocks are saturated with water. The source of this water is precipitation, which percolates down from the surface. The water table usually is a subdued reflection of the configuration of the surface topography, but it fluctuates seasonally and annually with variations in precipitation, pumpage, runoff, temperature, and other related factors.

Under normal water-table conditions water stands in a well at a height corresponding to that of the water table. Water-table conditions cease to exist, however, when a permeable aquifer is underlain and overlain by impermeable or nearly impermeable beds that serve to build up a water-pressure head within the aquifer. Under these circumstances an artesian system is created and water will rise in a tightly cased well to a level above the top of the containing bed and may flow out of the well. Flowing wells are not common in Columbia County and only 21 of the well records collected are of flowing wells. Over half of these wells are at the foot of a hill or mountainous area.

The water enters the aquifer in areas of rock outcrop or thin pervious overburden in the uplands and then follows joint or bedding planes through the folded, contorted beds down to the valleys where, when liberated by wells, it flows to the surface. Each well represents purely local conditions and there appears to be no evidence of any widespread artesian aquifer in the County.

RECOVERY

Ground water in Columbia County is recovered principally by means of wells, and only a comparatively few springs are used as a source of supply. More than 95 percent of the records collected are of drilled wells. The remaining records are of large-diameter dug wells and small-diameter driven wells. A special effort was made to collect records of drilled wells, as they are generally deeper and thus give a more complete record of geologic conditions. The percentages given above, therefore, do not necessarily represent the actual distribution of drilled versus dug wells in the County, nor a true picture of the water-yielding capacities of the aquifers.

Dug Wells

Dug wells are found mainly in rural areas, and in most places are used for domestic or farm supplies. Most of the dug wells are 3 to 5 feet in diameter and 10 to 20 feet in depth. Because of the large infiltration area available, the dug well is able to obtain water from relatively impermeable water-bearing materials. This characteristic, coupled with the large storage capacity of the dug well enables such wells to supply an adequate amount of water for many homes and farms. The shallow dug well, however, is likely to fail during protracted dry periods when the water table is at an exceptionally low stage. Moreover, the dug well generally has a loose casing or is improperly covered and, unless adequately located and constructed, is subject to pollution.

Driven Wells

Driven wells are used primarily for farm or domestic supplies. They range from 1¼ to 2 inches in diameter, are generally 10 to 20 feet in depth, and are equipped with a screen (well point) about 3 feet in length. This type of well can be put down only in soft, permeable materials because the presence of boulders, "hardpan," or other impediments prevents further driving. These wells afford satisfactory domestic or farm supplies when the aquifers they penetrate are moderately permeable. However, the well points may be subject to silting, which reduces the yield. The driven well is cased more tightly than the dug well and thus the chances of pollution are lessened. Unlike the drilled well, however, the driven well does not require the use of expensive equipment and trained personnel for installation.

Drilled Wells

Records of more than 800 drilled wells were obtained in Columbia County. A large majority of these are 6 inches in diameter and are used for domestic or farm supplies. The wells average about 120 feet in depth, the deepest being well Cb 228, which is 1,056 feet deep.

Wells obtaining water from rock are usually cased down to the rock and the hole below is left open. Surface and shallow soil waters theoretically are kept out, water entering only from openings in the rock. The rocks in Columbia County are generally dense and impervious, and they yield water only through joints, fractures, and cleavage and bedding planes. These openings tend to be compressed and pinched out with depth, and it is generally inadvisable to drill deeper than 150 to 200 feet in rock if an adequate supply of water has not already been obtained. If yields are inadequate under such conditions, it is generally considered advisable to drill a new well in an effort to strike a set of more productive rock openings.

Drilled wells that obtain water from the unconsolidated deposits in Columbia County generally are cased to the bottom of the well, water entering the well only through the small open end at the bottom of the casing. This method of intake does not permit full development of the aquifer; much larger quantities of water could be withdrawn from the same sediments if more modern and efficient methods of well finishing were employed.

Construction and Development of Wells

The efficiency of a well is measured in large part by its *specific capacity,* which has been defined as the rate of yield per unit of drawdown, usually given in gallons per minute per foot of drawdown. For example, well Cb 856 yields 220 gallons per minute with a drawdown of 7.5 feet and thus has a specific capacity of slightly more than 29 gallons per minute per foot of drawdown. The specific capacity and general efficiency of a well can be improved by increasing its intake area.

In this way the velocity of the water entering the well decreases, the frictional losses decrease, and, consequently, the amount of water than can be withdrawn with a unit lowering of the water level in the well increases.

A relatively simple method of increasing the intake area of a well is to perforate the part of the casing opposite the water-bearing beds. These perforations, however, may become clogged by sand and other fine material drawn through the open bottom, and a better method is to plug the bottom of the well and install a screen opposite the water-bearing bed. However, no great improvement in yield will be obtained unless the openings in the screen are the proper size. Good practice calls for a mechanical analysis of the water-bearing material opposite the screen to determine the proper size of screen openings, so as to combine maximum intake area with maximum protection against sand clogging. A gravel-wall or gravel-packed well may be used where the water-bearing material is composed of fine-grained sand that otherwise would require exceedingly fine screen openings. Although several methods of construction are possible, they are all designed to produce an envelope of uniform-sized gravel around the well screen. This permits use of larger-sized screen openings and consequently the recovery of a larger amount of ground water from the formation. The following table shows the intake areas provided by different methods of finishing a well:

Table 2.—Approximate area of intake openings of open-end casings, perforated casings, and well screens

Diameter of casing (inches)	Intake area of open-end casing (square inches)	Intake area of 5-foot length of perforated casing and well screen, closed end (square inches)		
		Casing perforated with ¼-inch holes on 3-inch centers	Well screen	
			Intake area 10 percent of screen area	Intake area 20 percent of screen area
12	113	14	226	452
6	28	7	113	226
4	13	5	76	151
2	3	2	38	75

The superiority of a screened well over the other types of vertical wells in providing a large intake area is readily seen. The advantages of screening, gravel-packing, and other methods of well construction are particularly evident when an aquifer consists of the fine lacustrine sands that are fairly widespread in Columbia County. These sands yield little or no water without proper construction and development, and heretofore drillers have passed through these so-called dry beds in search of water in the rock below. Except where a supply of only a few gallons a minute is needed, this generally is unwise because a properly constructed and developed well in a water-bearing sand should yield substantially larger quantities of water than a well in the dense impervious bed-rock that underlies Columbia County.

Not only the sands, but even the gravel deposits in the area have been neglected, and there are numerous records of wells that pass directly through gravel layers to dense rock scores of feet deeper, which yields but a few gallons per minute. Most gravel deposits will yield substantial quantities of water if they are properly developed. Wells are "developed" primarily to increase the yield at a given drawdown or to reduce the drawdown as much as possible when pumping at the designed rate.

Methods commonly used to improve the yield of a well include *surging, overpumping, back-washing,* and *acid treatment.* With the exception of the acid-treatment method, each is designed to wash the fine sand, silt, and clay from the water-bearing formation immediately surrounding the well screen and assist in the building up of a natural gravel wall around the screen. Thus water will enter the well more readily and the rate of yield per foot of drawdown (specific capacity) will be increased.

Surging a well is probably one of the best methods of development under the average conditions encountered in sand and gravel aquifers. The method utilizes some form of tight-fitting plunger that is operated up and down inside the well casing from a point about 15 feet below the static water level. This action surges the water in the sand or gravel formation, loosens the finer sand or gravel grains, and works them through the screen slots into the well, where they are periodically removed either by bailing or by pumping. The well is alternately surged and bailed (or pumped) until little or no more sand is pulled in through the screen. The surging method is particularly effective inasmuch as the forceful stirring of the water repeatedly disturbs the finer sand particles and prevents them from bridging against each other to close the voids or openings between the larger grains or pebbles.

The overpumping method of developing a well that taps a sand or gravel aquifer involves pumping it at rate that creates excessive drawdown. This rate may or may not exceed the rate at which the finished well is to be pumped, depending upon the condition of the well at the time drilling is completed. The method is intended primarily to clear the well at or below the maximum rate at which it is capable of yielding water, and it cannot be used effectively to build up any graded envelope of gravel around the screen. If the well clears satisfactorily at a final rate considerably in excess of the desired rate of pumpage, it is safe to assume the well will not fail in regular service. If it does not clear, or if the desired rate of pumpage cannot be reached, then some more effective means of development must be used. The method is better suited for use at sites where it is anticipated that not much sand will be pumped during the development process.

Developing a well by backwashing may be accomplished by a number of different methods, each of which surges or agitates the water in the formation at the well, preventing "bridging" of the sand particles and removing a large portion of the finer material. If a pump is used three different operating procedures are possible to secure the desired results. (1) The pump may be operated at its highest capacity until maximum drawdown of the water level is obtained, whereupon it is then stopped, the water is drained rapidly out of the pump column, and the well is allowed to regain its original static water level. The process is repeated until no further improvement in yield is noted. (2) The pump may be operated to obtain maximum drawdown and then stopped and started alternately at short intervals. Thus the water level in the well is held down and frequently agitated in the formation adjacent to the well by the backwash of water in the pump column. (3) The pump may be operated until water begins to discharge at the surface. The pump is then stopped and the water allowed to drain from the column. The process merely agitates the water in the formation, and is repeated as many times as is necessary.

Backwashing may also be performed by pouring water into the well as rapidly as possible and then bailing vigorously with a sand pump or bailer. Where possible a more forceful method utilizes a watertight hose or pipe connection to the top of the well permitting water from a standpipe or pressure main to be forced down in large volume and under high pressure for 2 to 5 minutes. The connection is then removed and the well bailed vigorously.

Acid treatment of a well provides a means for regaining some of the yield that has been lost because of gradual incrustation of the well screen. All ground water is corrosive or incrusting to a certain degree, depending on the amount and kinds of substances it contains in solution. Under pumping conditions some of the salts normally held in solution in ground water may be precipitated on the well screen and on the gravel and sand grains adjacent to the screen, owing to the sudden decrease in pressure as the water flows from the formation into the well. This is particularly apt to occur where the water contains carbonate or sulfate salts. If the screen is constructed of brass, bronze, or stainless steel these incrustations may be removed by introducing at the screen level a sufficient quantity of commercial hydrochloric acid (for carbonate or iron deposits) or sulfuric acid (for sulfate deposits) to create a 10- to 25-percent solution. This is allowed to stand for 1 to 2 hours; the well is then gently surged for several minutes and allowed to stand again for 2 hours or more. Finally the well is bailed clean and pumped for at least 1 hour. Depending upon the yield noted during this pumping period, the process may need to be repeated one or more times.

Other methods of improving or developing the yield of a well include dynamiting and combined surging and pumping through use of compressed air or surge blocks. "Dry ice" may be used to simulate surging or pressure effects through the bubbling action that occurs when it is submerged in the well. Local conditions will usually suggest, if not determine, the particular method of development that should prove most effective.

Infiltration Galleries

An infiltration gallery is essentially a long, horizontal, shallow well dug into the zone of saturation. Galleries commonly are used in areas where aquifers have relatively low permeability or where relatively large supplies are required with relatively small drawdowns. A secondary advantage of infiltration galleries is that they may have a large quantity of water available for immediate emergency requirements. The only installation of this type in Columbia County is Cb 865 which is part of the public-supply system at Valatie.

Springs

In addition to wells a few springs supply ground water in Columbia County (table 3). Most of the springs for which records have been obtained are gravity springs of the contact type or the depression type. The aquifer supplying the contact type is underlain by relatively impermeable deposits and also intersects the land surface, usually on a hill slope; ground water moves laterally in the aquifer and is discharged along the contact of the aquifer and the underlying impermeable deposits. In the depression type, ground water forms a pond or stream because the water-table is above the ground surface.

Springs occur throughout the County and generally are of fifth magnitude (Meinzer, 1923, p. 53), having yields of 10 to 100 gallons per minute, or less. They are used almost exclusively for domestic or farm supplies. The largest spring visited in the County is Lebanon Warm Spring (Cb 11Sp), which yields about 75 gallons per minute and is used to maintain a warm spring resort. The temperature of the water from Cb 11Sp is 73° F., or about 20° warmer than the normal temperature of the ground water in relatively shallow water-bearing beds in the area. Spring Cb 11Sp issues from a gravel deposit that overlies the Stockbridge limestone near the contact of the latter with metamorphosed beds of Normanskill shale. There is evidence of a fault in the vicinity (Stearns, 1937, p. 170). The source of the heat is not known definitely; it may be deep-seated or perhaps due to high geothermal gradient resulting from movement along a fault. It has been postulated the water is of surface origin, but has penetrated to considerable depth and has returned to the surface along fractures (Stearns, 1937, p. 75).

UTILIZATION

Of the 885 wells and springs inventoried in Columbia County 831 are used for domestic or farm supplies. Of the remainder, 16 wells supply water for drinking and sanitary purposes at schools, 7 are used at garages and filling stations, 6 are used at hotels or restaurants, 13 wells and 2 springs are used by industries, and 10 wells furnish public supplies. The pumpage of ground water for farm and domestic use, exclusive of municipal supplies, is estimated at 2 million gallons per day. The total pumpage of ground water in Columbia County is estimated at approximately 3.2 million gallons per day.

Domestic Supplies

Except in the communities that have a public supply, domestic water supplies throughout the County are obtained almost exclusively from privately owned wells and springs. The domestic uses of water include drinking, cooking, washing, and sewage disposal, and these needs are normally met by dug, driven, or drilled wells that yield several gallons per minute each. Water for cattle and other animals also is obtained by wells and where the number of stock to be cared for is small, one well may suffice for both the stock and the household. The average withdrawal of water from wells for these uses is estimated to be less than 500 gallons per day. Many of the orchards in Columbia County are sprayed periodically during the spring, when the consumption of water may rise to an average of about 5,000 gallons per day per well.

Records were obtained of wells at 16 schools, both public and private. Most of the schools are small and the total consumption, therefore, is small. Records for four of the larger schools, at which shower or living facilities are available, indicate a much greater consumption of water. The largest amount used is at the Berkshire Industrial Farm School, reported to obtain 16,000 gallons per day from well Cb 119. In the column headed "Use" in table 6, school wells are classified as domestic.

Commercial Supplies

Records were obtained for 7 wells at garages or filling stations and 6 wells at roadside restaurants or hotels. The water from these wells is used for domestic and related purposes, and the average consumption is probably less than 1,000 gallons per day. These wells are classified as commercial in table 6.

Table 3.—Records of selected springs in Columbia County, N. Y.

Location: For explanation of location symbols see section, "Introduction".
Altitude above sea level: Approximate altitude, from topographic map.

Use: Dom, domestic; Ind, industrial; Med, medicinal; PWS, public water supply.

Spring number	Location	Owner	Altitude above sea level (feet)	Topography	Geologic subdivision	Yield (gallons per minute)	Temperature (° F.)	Use	Remarks
Cb 1Sp	11Y, 4.3S, 9.2E	C. C. Benedict	500	Base of cliff	Nassau formation	2	49	Farm	Seasonal fluctuation large.
Cb 2Sp	11Y, 9.5S, 0.4E	S. S. Drum	200	Hillside	Pleistocene sand	.25	50	Farm	([a])
Cb 4Sp	11Y, 10.8S, 9.5E	Alfred Terrell	600	do.	Normanskill shale	6.5	..	Farm	
Cb 6Sp	11Y, 11.9S, 10.4E	Village of Spencertown	680	do.	do.	4	50	Dom	
Cb 7Sp	11Y, 13.2S, 11.6E	James Pinto	1,100	do.	do.	..	46	Dom	
Cb 8Sp	11Y, 14.2S, 9.8E	F. Wamback	1,050	Upland	Pleistocene gravel	4	..	Farm	
Cb 9Sp	11Y, 16.8S, 8.8E	A. D. Ficke	980	Hillside	Normanskill shale	2.5	50	Dom	
Cb 11Sp	11Z, 1.3S, 6.7E	Town of New Lebanon	910	do.	Stockbridge limestone	75	73	Med	Warm Spring resort.[a]
Cb 12Sp	11Z, 10.9S, 2.5E	James Foley	1,530	Upland	Pleistocene sand	..	49	Farm	
Cb 13Sp	11Z, 16.1S, 0.5E	Alexander Bloch	1,080	Hillside	Normanskill shale	..	..	Farm	
Cb 18Sp	12Y, 3.0S, 3.7E	Henry Baird	480	do.	Pleistocene gravel	..	50	Farm	
Cb 19Sp	12Y, 12.0S, 10.8E	Frank Dunning	580	Swamp	do.	..	..	Farm	
Cb 20Sp	12Y, 12.6S, 9.7E	Carl Rockefeller	510	do.	Stockbridge limestone	..	..	Farm	
Cb 21Sp	12Y, 16.2S, 8.2E	Borden Milk Co.	560	do.	Pleistocene gravel	..	..	Ind	
Cb 22Sp	12Y, 0.6S, 1.0W	Greenport Water Works	200	Base of cliff	Manlius limestone	60	50	PWS	Seasonal fluctuation large.[a]
Cb 24Sp	12Y, 7.3S, 2.0W	Albert Mogerly	200	Swamp	Pleistocene gravel	25	50	Farm	
Cb 25Sp	12Y, 10.4S, 8.6W	Frank Wasburn	120	Hillside	Normanskill shale	..	..	Dom	
Cb 26Sp	12Y, 6.7S, 8.4E	Leroy Van de Carr	800	do.	do.	..	..	PWS	([a])
Cb 28Sp	12Y, 4.4S, 2.4W	Clarence Gardner	250	do.	do.	2	47	Dom	Water is bottled and sold.

[a] For chemical analysis see table 4.

Industrial Supplies

Most of the existing industrial activity in Columbia County is concentrated in the city of Hudson and in the other villages that have municipal water supplies. Any large demand for water for industrial purposes has been met so far by the municipal supplies.

Records of 15 privately owned wells or springs used exclusively for industrial purposes show that the pumpage from each is small and only three wells have an average annual pumpage that exceeds 10,000 gallons per day. Well Cb 486 supplies 28,000 gallons per day, which is used for cooling and air conditioning at the Universal Match Co. plant. During the summer an additional supply of 37,000 gallons per day is pumped from well Cb 487. The largest single industrial consumer in the County is the Hudson Glue Factory, which pumps 156,000 gallons per day from well Cb 854 for cooling purposes. Several other wells at orchards, canning factories, or refrigeration plants pump more than 10,000 gallons per day during the summer, but are not operated during the rest of the year. Peak ground-water withdrawals for industrial purposes in Columbia County do not greatly exceed 300,000 gallons per day.

Public Supplies

There are 10 public water supplies in Columbia County each of which serves over 100 people or has an average daily demand of more than 3,000 gallons. Five of these use ground water and the average daily pumpage is about 700,000 gallons. Half of this total is supplied through the Chatham municipal system.

The Chatham municipal supply furnishes water to the villages of Chatham and Ghent. Water is pumped from two wells (Cb 286 and Cb 287) 65 feet deep, which tap a shallow bed of gravel. The water is pumped to an earthern reservoir and from there is distributed at the rate of about 350,000 gallons per day. The water is chlorinated and has an average hardness of about 102 parts per million.

The town of Copake has no public supply but the cottages that surround Lake Copake are supplied with water from two sources. The first is an 8-inch well (Cb 716) of the Lake View Cottage Owners Association, which penetrates about 200 feet of the Normanskill shale and is pumped at the rate of 12 gallons per minute. The water is pumped to a 7,000-gallon reservoir from which it is delivered by gravity at the rate of about 4,000 gallons per day. The water is not treated. A chemical analysis of the water is given in table 4. There is an auxiliary well (Cb 715) which is 6 inches in diameter and 134 feet deep. This well also taps the Normanskill shale and is reported to yield 8 gallons per minute. The second public supply at Lake Copake is owned by Mr. Leroy Van de Carr. It consists of a spring (Cb 26Sp) that issues from the Normanskill shale and an auxiliary well (Cb 710) that is 121 feet deep and also taps the Normanskill shale. The yield of this well is reported to be 100 gallons per minute. The water, which is not treated, is pumped to an 8,000-gallon reservoir and from there distributed at the average rate of 15,000 gallons per day. A chemical analysis of the water from the spring is given in table 4.

The Greenport Water District is supplied by a dug well (Cb 470) that is 18 feet deep and 30 feet in diameter. It taps a shallow bed of gravel and has a reported yield of 100 gallons per minute. The water is pumped to a 140,000-gallon steel tank and from there is distributed by gravity. Consumption averages about 65,000 gallons per day. The water is not treated. In addition to this well, a spring (Cb 22Sp) supplies approximately 40,000 gallons per day. The water from the spring is chlorinated. A chemical analysis of the untreated spring water is given in table 4.

The public supply at Kinderhook consists of a drilled well (Cb 91), 31 feet deep and 8 inches in diameter, that draws water from alluvial deposits along Kinderhook Creek. The well is screened and is pumped at the rate of 100 gallons per minute. The water is delivered to a 100,000-gallon elevated steel tank and from there distributed by gravity at the average rate of 100,000 gallons per day. The water is chlorinated. An analysis of the untreated water is given in table 4. In October 1947, two additional wells were drilled. These wells (Cb 855 and 856), near the site of well Cb 91, are 35 feet and 32 feet deep, respectively and draw water from the same water-bearing beds. Also the yield of well Cb 855 is 110 gallons per minute and that of well Cb 856 is 220 gallons per minute. Both wells are finished with screens and, in addition, well Cb 856 has been gravel-packed at the end of pumping test of well Cb 856. A 7.5 foot-drawdown was measured after 6 hours of pumping at 220 gallons per minute.

The public supply of the village of Valatie consists of three drilled wells and one dug well, all of which extract water from shallow alluvial deposits. The dug well (Cb 865) is 4 feet in diam-

eter and 20 feet deep, and is connected to an infiltration gallery. The latter consists of 50 feet of tile pipe laid in a horizontal trench which is backfilled with crushed stone, about 30 feet west of Kinderhook Creek. The sections of the tile pipe have been left unconnected and water is drawn in through the openings between them. The original yield of this well was 350 gallons per minute, but because of silting the yield has declined to about 100 gallons per minute. The drilled wells, all 8 inches in diameter, range in depth from 35 to 52 feet and in yield from 75 to 150 gallons per minute. Each is finished with a brass well screen 5 feet in length. Water from all the wells is drawn through one suction pump and is delivered to a 150,000-gallon elevated steel tank, whence it is distributed by gravity at the average rate of about 150,000 gallons per day. The water is chlorinated. A chemical analysis of the untreated water from well Cb 865 is given in table 4.

QUALITY

Some of the chemical characteristics of the ground water of Columbia County are shown by the analyses in table 4. Analyses are listed for 24 samples collected by the U. S. Geological Survey and analyzed in the laboratories of the New York State Health Department at Albany or the U. S. Geological Survey at Washington, D. C. The sites of the wells and springs from which samples were collected are shown in figure 4.

Chemical Constituents and Physical Properties

Dissolved solids.—The dissolved solids—the residue left after evaporation of the water—consist primarily of the dissolved mineral constituents in the water. They may also contain some organic matter and water of crystallization. Waters with less than 500 parts per million (one grain per U. S. gallon equals 17.118 parts per million) of dissolved solids are generally entirely satisfactory for domestic use except for the difficulties resulting from excessive hardness or iron content. Waters with more than 1,000 parts per million are likely to contain enough of certain constituents to produce a noticeable taste or to make the water unsuitable in other respects. Only one of the samples of ground water in Columbia County contained over 1,000 parts per million of dissolved solids and only four others contained over 400 parts per million (fig. 4). Water obtained from the unconsolidated deposits in Columbia County is generally lower in dissolved solids than that obtained from the consolidated rocks. Of the latter, the limestones of Devonian age in the Becraft outlier yield waters that are higher in dissolved solids than do the other formations in the County. Well Cb 576 contains 2,840 parts per million of dissolved solids. The exact explanation for such a high mineral content in the ground water in Columbia County is not clear, but it is believed to be purely a local occurrence that in no way indicates conditions elsewhere in the County.

Iron (Fe).—Iron is dissolved from many rock materials. If a water contains much more than 0.3 part per million the excess may separate out when exposed to the air and settle as a reddish sediment. Dissolved iron sometimes stains cooking utensils and plumbing fixtures and is very troublesome to such industries as laundries, tanneries, and paper manufacturing. Iron is found in measurable amounts in many of the ground waters of Columbia County but less than one-third of the samples analyzed contained over 0.3 part per million of iron. The largest quantity of iron, 9.0 parts per million, was found in the sample from well Cb 576. The mean iron content of the samples (excluding well Cb 576) shown in table 4 is 0.28 part per million.

Manganese (Mn).—When present in quantities greatly exceeding 0.05 part per million, manganese causes gray to black discolorations on many of the materials it contacts. It may also clog pipe and is particularly troublesome in laundry and textile plants. Five of the samples analyzed (table 4) contained over 0.05 part per million of manganese, and the highest of these is from well Cb 20, which contained 1.2 parts per million. The mean manganese content (excluding well Cb 20) of the samples analyzed, shown in table 4, is 0.04 part per million.

Chloride (Cl).—Chloride is an important constituent of sea water and is dissolved in small quantities from many rock materials. The U. S. Public Health Service recommends 250 parts per million as an upper limit for chloride content of potable water to be used in interstate commerce. No concentrations even approaching this limit have been reported in Columbia County and only four of the analyses shown in table 4 indicate chloride content exceeding 10 parts per million. The sample from well Cb 138 had the largest quantity of chloride, 78 parts per million. The mean chloride content for the wells and springs shown in table 4 is 8.7 parts per million.

Sulfate (SO_4).—Sulfate is dissolved in large quantities from gypsum; it is formed from the oxidation of iron sulfide (principally pyrite-FeS_2), and it is also present in connate water. Sulfate itself has little effect on the general use of a water, although magnesium sulfate and sodium sulfate

Table 4.—Chemical analyses of water from wells and springs in Columbia County, N. Y.

(Analyses by New York State Department of Health unless indicated otherwise. Dissolved constituents given in parts per million.)

Well or spring number	Depth (feet)	Geologic subdivision	Date of collection	Dissolved solids	Iron (Fe)	Manganese (Mn)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Hardness calculated as $CaCO_3$: Total	Carbonate	Non-carbonate	Total alkalinity (as $CaCO_3$)	pH
Cb 13	195	Schodack formation	11–25–47	224	0.18	0.06	160	40	1.0	104	104	0	131	7.7
Cb 20	20	Pleistocene sand	1– 8–47	232	2.3	1.2	177	36	3.4	148	145	3	145	6.9
Cb 30	700	Normanskill shale	11–15–45	154	.06	.0	137	16	1.4	92	92	0	112	7.7
Cb 39	6	Pleistocene gravel	11–15–45	67	.15	.0	22	12	2.8	32	18	14	18	6.8
Cb 63	21	Pleistocene sand	10–11–45	122	.03	.0	22	23	4.6	66	18	48	18	6.0
Cb 91	31	Recent alluvium	10–12–45	172	.03	.0	104	23	4.0	98	85	13	85	6.8
Cb 105	280	Nassau formation	1–10–47	171	.20	.03	157	20	5.4	108	108	0	129	7.7
Cb 138[a]	84	Normanskill shale	8–28–47	302	.12	.0	167	14	78	46	46	0	137	7.6
Cb 174	64	Rensselaer graywacke	11–28–47	211	.15	.08	170	18	1.4	164	139	25	139	7.6
Cb 220	218	Nassau formation	7– 9–46	538	.60	.01	481[b]	41	7.8	20	20	0	394	8.4
Cb 332	81	Stockbridge limestone	1–15–47	275	.35	.01	300	13	2.0	300	246	54	246	7.5
Cb 568	87	Schodack formation	11–26–47	482	.12	.0	351	69	3.2	370	288	82	288	7.1
Cb 576	140	Normanskill shale	10– 2–47	2,840	9.0	.40	407	1,540	11	1,700	334	1,370	334	7.2
Cb 716	200	do.	4–19–47	254	.02	.0	209	42	1.2	254	171	83	171	7.7
Cb 737	68	Stockbridge limestone	11–26–47	292	.05	.0	288	23	4.6	300	236	64	236	7.4
Cb 817	150	Nassau formation	11–26–47	80	.45	.0	17	10	5.0	34	14	20	14	5.5
Cb 857	50	Coeymans limestone	11–29–47	520	.07	.0	285	72	18	430	234	196	234	7.0
Cb 858	118	New Scotland limestone and Coeymans limestone	11–29–47	569	.22	.0	350	156	5.2	400	287	113	287	7.0
Cb 860	305	Normanskill shale	9– 3–47	313	.15	...	245[c]	18	30	42	42	0	201	9.1
Cb 865	20	Recent alluvium	10–10–45	94	.40	.0	61	20	4.2	60	50	10	50	6.9
Cb 2Sp	...	Pleistocene sand	7–15–46	181	.20	.25	10	93	2.6	98	8	90	8	5.4
Cb 11Sp	...	Stockbridge limestone	11–15–45	139	.10	.0	154	23	7.8	148	126	22	126	7.7
Cb 22Sp	...	Manlius limestone	4–17–47	298	.03	.0	201	75	3.2	230	165	65	165	7.4
Cb 26Sp	...	Normanskill shale	4–10–47	59	.50	.01	17	12	1.6	22	14	8	14	6.7

[a] Analysis by Quality of Water Branch, U. S. Geological Survey: Silica, 10 p.p.m.; calcium, 12 p.p.m.; magnesium, 4.0 p.p.m.; sodium and potassium, 100 p.p.m.; fluoride, 0.2 p.p.m.; nitrate, 1.9 p.p.m.
[b] Includes equivalent of 60 p.p.m. of carbonate (CO_3).
[c] Includes equivalent of 25.2 p.p.m. of carbonate (CO_3).

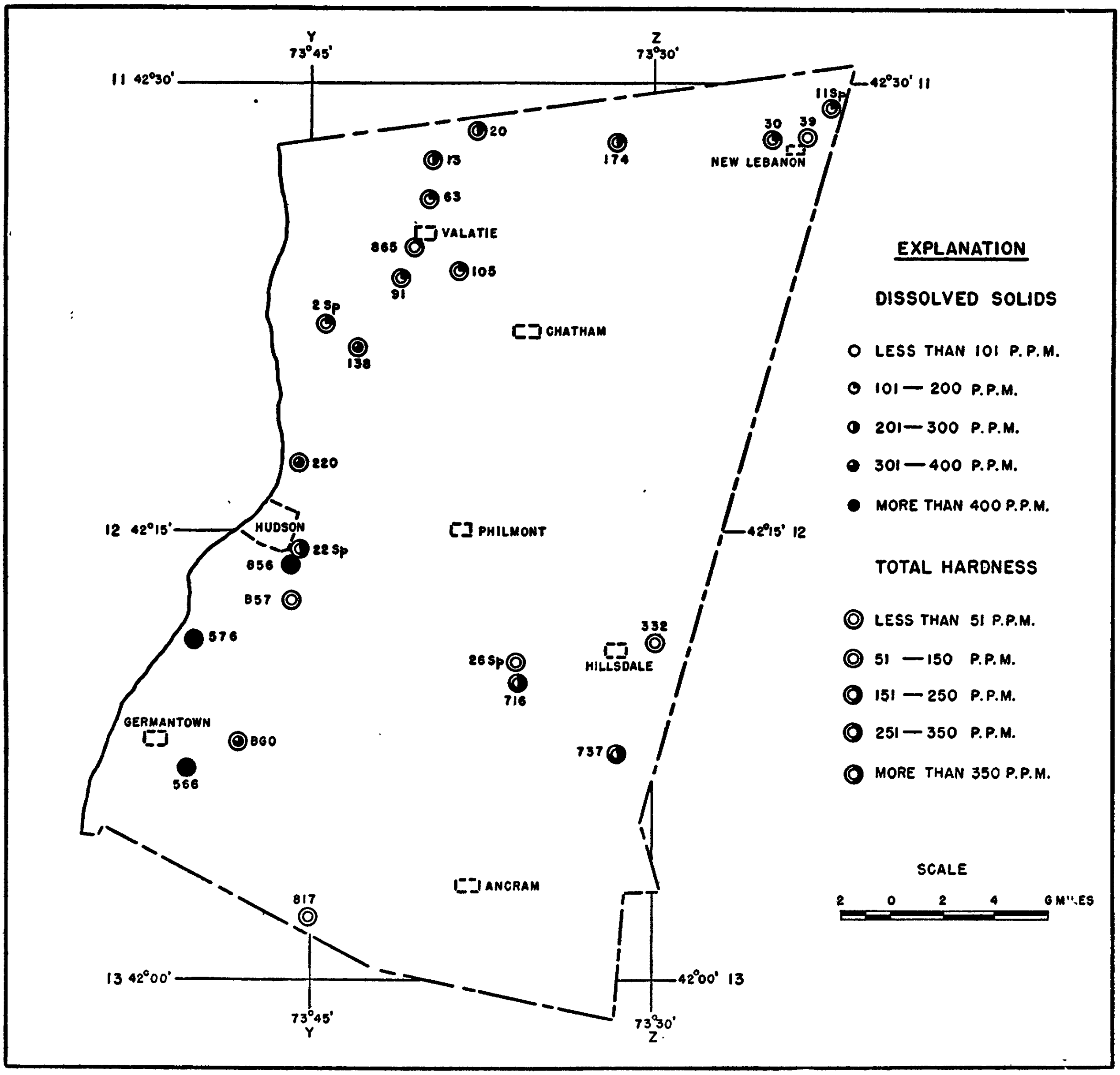

Figure 4.—Areal distribution of dissolved solids and total hardness in well and spring waters. Columbia County, N. Y.

may be present in sufficient quantity to give a bitter taste. Sulfate in a hard water may increase the cost of softening and will make the scale formed in a steam boiler more difficult to remove. Only two of the analyses in table 4 show more than 100 parts per million of sulfate—of water from well Cb 858, which has 156 parts per million, and from well Cb 576, which has 1,540 parts per million. The mean sulfate content according to the analyses shown in table 4 (excluding Cb 576) is 3[illegible] parts per million.

Hardness.—The hardness of a water is most commonly recognized by the amount of soap required for washing. The constituents that cause hardness, calcium and magnesium, are usually the principal constituents of the scale formed in steam boilers and in other vessels in which water is heated or evaporated. Table 4 shows not only total hardness but also carbonate and noncarbonate hardness. Carbonate hardness, or temporary hardness, is caused by the presence of calcium and magnesium bicarbonate, and can largely be removed by boiling the water. Noncarbonate hardness, permanent hardness, is due principally to the presence of calcium and magnesium sulfate or chloride and cannot be removed by boiling. The noncarbonate hardness generally forms a harder scale, but there is no difference between the two as far as consumption of soap is concerned.

Water having a hardness of less than 50 parts per million is generally rated as soft and treatment for the removal of hardness is rarely justified. Hardness of 50 to 150 parts per million does not seriously interfere with the use of water for most purposes, but it does slightly increase the consumption of soap; its removal by a softening process is profitable for laundries or other industries that use large quantities of soap. Treatment for the prevention of scale is necessary for the successful operation of steam boilers using water having hardness in the upper part of this range. Where the hardness is 200 or 300 parts per million, or higher, it is common practice to soften water for household use or to install cisterns to collect rain water. When municipal water supplies are softened an attempt is generally made to reduce the hardness to about 60 parts per million. The additional improvement from further softening is not deemed worth the added cost.

The hardness of ground water in Columbia County ranges widely, depending upon the source beds, and in eight analyses the hardness is over 200 parts per million (table 4). The water from well Cb 576 has a total hardness of 1,700 parts per million, which is an exceedingly high concentration for a water not classed as a mineral water. In general, the limestones in Columbia County yield the hardest water, and spring water from a given formation is softer than well water from the same formation.

Hydrogen-ion concentration (pH).—The pH value of a water is the negative exponent of the concentration of hydrogen ions in grams per liter. Thus a low pH value means a high concentration of hydrogen ions, or a high acidic value; a high pH value indicates a low concentration of hydrogen ions, or a low acidic value. A neutral water has a pH value of 7.0. The ground waters of Columbia County range in pH value from 5.4 to 9.1, and have an average value of about 7.0. A determination of the pH value should be made immediately after the sample is collected because changes in the alkalinity of the water occur upon exposure to the air. The analyses in table 4 were not made until several days after the samples were collected, and the pH values reported may not accurately represent the original waters at the time they were withdrawn from wells and springs.

Temperature (° F.).—When water is used for cooling or air-conditioning, the temperature of the water is usually of equal importance to its chemical characteristics. Water having a low temperature is desired, and water that maintains a low temperature consistently throughout the year is preferred. In this respect, ground water is superior to surface water. The temperature of the surface water reflects directly the local atmospheric conditions and may vary from about 32° F. to over 80° F. during the course of a year. Ground water, however, regardless of the season, generally maintains a temperature only slightly above the mean annual air temperature of the region. The temperature of water obtained from shallow wells may vary somewhat during the year but the temperature of water obtained from deep wells remains constant. The mean annual air temperature at Columbia County is about 47° F., and the ground-water temperatures listed in tables 3 and 6 indicate an average of about 49° F. One exception is the spring Cb 11Sp, which is reported to have a year-round temperature of 73° F., more than 20° warmer than the average temperature of ground water of the area. Consequently it is classified as a "warm spring." The reason for the relatively high temperature is not known but it may be related to contact of water with rocks heated by movement along a fault.

An attempt was made to observe the temperature of the ground water at all wells visited but in many places it was found impossible to obtain a reading before the water had passed into a storage tank. These tanks are often in heated cellars or next to hot-water pipes, and the temperature of the stored water is often many degrees higher or lower than the temperature of the water

in the well or spring at the point of emergence. The temperatures listed in tables 3 and 6 have been limited to those that were obtained for water issuing directly from a spring or well.

Quality of Water in Relation to Rock Type

Shale.—Included in the classification "shale" are the Nassau formation, the Schodack formation, and the Normanskill shale. In the following discussion the analysis from well Cb 576 will not be considered. The total mineral content of ground water in the shale ranges from less than 100 to more than 500 parts per million and the average is about 260 parts per million. The iron content ranges from 0.02 to 0.6 part per million and averages 0.24 part per million. The manganese content ranges from less than .01 to 0.06 part per million and averages 0.03 part per million more than half the samples had no measurable amounts of manganese. The sulfate content ranges from 10 to almost 70 parts per million and averages about 30 parts per million. The chloride content ranges from 1.0 to 78 parts per million and averages 13 parts per million. Total hardness ranges from 22 to 370 parts per million and averages 109 parts per million. The large differences in mineral constituents in water from shale is probably due, in part, to the presence of insoluble chert, grit, and quartzite beds, and soluble limestone lenses that are interbedded with the shale.

Limestone.—Among the limestones in Columbia County, are the Stockbridge limestone and the Devonian limestones of the Becraft Mountain outlier. The dissolved solids content of ground water from these aquifers differs greatly, that from the Stockbridge ranging from 139 to 292 parts per million and that from the Devonian limestones ranging from 298 to 569 parts per million. The iron and chloride content of each group is roughly similar, averaging 0.14 and 6.8 parts per million, respectively. The manganese content of each averages less than 0.01 part per million. The water from the Devonian limestones is harder and has a higher sulfate content than does water from the Stockbridge limestone. Water from the Stockbridge limestone has an average sulfate content of 20 parts per million and an average hardness of 249 parts per million. Analyses of water from the Devonian limestone, on the other hand, indicate an average sulfate content of 101 parts per million and an average hardness of 353 parts per million, thus exceeding the average for ground water in the County as a whole.

Unconsolidated deposits.—According to six analyses shown in table 4, ground water from the unconsolidated deposits in Columbia County generally has a lower mineral content than has ground water from the consolidated rocks in the County. The dissolved solids in the water from unconsolidated aquifers averages 145 parts per million, which is less than half the average mineral content of water in the consolidated rocks of the County. The average content of chloride and sulfate in ground water from the unconsolidated deposits is about 4 and 35 parts per million, respectively, as compared to an average chloride content of 10 parts per million and a sulfate content of 37 parts per million in water from the consolidated rocks of the County. Iron and manganese, however, are present in somewhat greater concentrations in the unconsolidated deposits than in the consolidated deposits. Analyses of ground water from consolidated deposits in the County show an average hardness of 180 parts per million, whereas water from the unconsolidated deposits has an average hardness of only 84 parts per million. This latter figure is low for water coming from aquifers in this part of the State.

SUMMARY OF GROUND-WATER CONDITIONS

Essentially all the ground water in Columbia County originates from precipitation on the immediate area. There is no indication of any widespread movement of ground water within the County or into the County from adjacent areas. The ground water generally is under water-table conditions and flowing wells are not common. No extensive artesian horizons are known to exist in the County.

The consolidated deposits in the area are dense, compact, impervious rocks that yield water only from joint, bedding, cleavage, or fracture openings. Such openings are difficult to anticipate and generally tend to pinch out with depth. Yields from the rock wells, therefore, show a considerable range but in most places are low. Yields are generally sufficient to meet domestic and farm demands, however, and bedrock consequently has been tapped by numerous wells. Owing to their wide area of outcrop, the shales (Nassau, Schodack, and Normanskill) are the most extensively tapped aquifers and yield an average of about 6 gallons per minute. The largest yield reported is 100 gallons per minute. The Stockbridge limestone and the Silurian and Devonian limestones of the Becraft outlier show an average yield of 11 gallons per minute, but owing to the small area of outcrop they are less extensively tapped than the shales. The total mineral content of ground water from both the limestone and the shale differs greatly. Nearly all the analyses of water samples from the shale show either moderate or low content of those chemical constituents of importance in the general use of water. Water from the limestones is generally hard and fairly high in dissolved minerals. The Devonian limestones yield water that is higher in dissolved solids than do the other formations in the County.

The unconsolidated deposits are the most productive aquifers in the County and water from these deposits generally has a lower total mineral content than does water from the consolidated rocks. The glacial drift ranges in character from unassorted till through well-sorted outwash deposits, and consequently there is considerable range in yields. The till and clay yield very little water, but the beds of sand and, particularly, gravel, may yield substantial quantities. The outwash deposits in Columbia County have been tapped by only a few wells; the relatively few records available show that only small yields have been obtained from unscreened, and largely undeveloped, wells. Many records are available of wells that have passed through "dry" sand and gravel deposits to end scores of feet lower in the dense bedrock, which yielded but a few gallons per minute. Lack of development of the unconsolidated deposits, however, is unwise because the sand and gravel may be expected to yield to properly constructed wells substantial quantities of water that will meet the demands of most industrial plants or municipalities. In areas where the glacial deposits are susceptible to recharge from nearby streams or lakes, relatively large withdrawals of water can be sustained without excessive lowering of water levels.

The largest yields in Columbia County are obtained from alluvial deposits in the Kinderhook Valley. The average yield from the seven wells of the Kinderhook and Valatie municipal supplies that tap the alluvium is about 130 gallons per minute. Scattered alluvial deposits are found near the larger streams throughout the County and are subject to river infiltration. If properly tapped by a modern, efficient well or infiltration gallery that is specifically designed to draw water from the particular formation present, the alluvium may be expected to yield large quantities of water.

The dissolved solids in the water from the unconsolidated rocks in the County is less than half of that from the water in the consolidated rocks of the County. Iron and manganese, however, are present in somewhat greater concentrations in the unconsolidated deposits than in the consolidated deposits. The average hardness of water from the unconsolidated deposits is low for water coming from aquifers in this part of the State.

Future exploration for large quantities of ground water in Columbia County would probably be most successful if conducted in glacial and alluvial deposits near bodies of surface water. Large supplies developed in deposits not subject to recharge face the possibility of gradual exhaustion.

Ground water in Columbia County is recovered almost exclusively by means of drilled wells, most of which tap bedrock. In addition there are a few dug and driven wells and some springs which generally have small yields and are of the gravity type. Most of the industry in the County is located in areas where municipal supplies can be utilized, and consequently there has been little demand for the development of ground water by industries. The total pumpage for industrial purposes from privately-owned wells throughout the County is less than 500,000 gallons per day. Five of the ten public-supply systems in Columbia County use ground water and the average daily pumpage is about 700,000 gallons. Half of this total is supplied through the Chatham municipal system. The pumpage of ground water for farm and domestic use, exclusive of municipal supplies, is estimated at 2 million gallons per day. This gives a total pumpage of ground water in Columbia County of approximately 3.2 million gallons per day.

There are no known areas in Columbia County where the supply of ground water is being critically depleted by overpumpage. On the contrary, the supply is sufficient to meet all present demands and is capable of supporting still larger pumpage in the future.

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Table 5.—Drillers' logs of selected wells in Columbia County, N. Y.

(Altitudes are interpolated from the topographic map)

		Thickness (feet)	Depth (feet)
Cb 12;	11Y, 3.2S, 3.3E; drilled by William Shaver in 1936; altitude 300 feet.		
	Topsoil	2	2
	Gravel	9	11
	Clay, yellow, no stone	25	36
	Quicksand	53	89
	Gravel, coarse	1	90
	Rock at	..	90
Cb 20;	11Y, 1.9S, 6.1E; driven well; altitude 360 feet.		
	Gravel	10	10
	Hardpan	5	15
	Sand, black	5	20
Cb 40;	11Z, 2.2S, 5.5E; drilled by Goold Bros. in 1932; altitude 700 feet.		
	Gravel	18	18
	Quicksand	70	88
	Hardpan and boulders with sand	10	98
	Limestone	41	139
Cb 61;	11Y, 5.8S, 4.5E; drilled by W. Shaver in 1936; altitude 320 feet.		
	Topsoil	2	2
	Sand, fine	18	20
	Gravel, coarse	25	45
	Rock at	..	45
Cb 68;	11Y, 4.0S, 3.3E; drilled by W. Shaver in 1930; altitude 310 feet.		
	Topsoil	2	2
	Gravel, fine	18	20
	Quicksand	76	96
	Clay	2	98
	Gravel, coarse	2	100
	Rock at	..	100
Cb 69;	11Y, 4.6S, 3.0E; drilled by W. Shaver in 1943; altitude 300 feet.		
	Topsoil	1	1
	Gravel, fine	8	9
	Quicksand	57	66
	Gravel, coarse	4	70
	Rock at	..	70
Cb 83;	11X, 4.4S, 12.7E; drilled by Germantown Artesian Well Co. in 1925; altitude 220 feet.		
	Clay and hardpan	24	24
	Limestone, shaly	26	50
	Limestone, very hard	77	127
Cb 90;	11Y, 6.0S, 2.4E; drilled by Germantown Artesian Well Co. in 1930; altitude 260 feet.		
	Sand	20	20
	Clay, yellow	50	70
	Sand, streak of clay	30	100
	Hardpan, gravel	8	108
	Shale rock	85	193

Table 5.—Drillers' logs of selected wells in Columbia County, N. Y. (Continued)

		Thickness (feet)	Depth (feet)
Cb 91;	11Y, 7.1S, 3.1E; drilled by W. Shaver in 1938; altitude 200 feet.		
	Topsoil	2	2
	Gravel, sandy	19	21
	Gravel, coarse	10	31
Cb 121;	11Z, 9.2S, 2.6E; drilled by G. Goold in 1942; altitude 1,000 feet.		
	Gravel	10	10
	Limestone and quartz	14	24
	Graphite schist, soft	46	70
	Limestone	3	73
Cb 127;	11Y, 8.0S, 5.6E; drilled by Goold Bros. in 1935; altitude 340 feet.		
	Hardpan	12	12
	Shale, soft, gray	17	29
	Slate, red	17	46
	Mixed limestone and black slate	25	71
Cb 141;	11Y, 9.7S, 0.3E; drilled by Germantown Artesian Well Co. in 1941.		
	Broken shaly soil and some clay	15	15
	Clay, blue and hardpan	14	29
	Shale rock	36	65
Cb 218;	11X, 12.6S, 12.5E; drilled well; altitude 140 feet.		
	Clay, yellow	50	50
	Clay, blue	50	100
	Hardpan and some gravel	15	115
	Shale rock	44	159
Cb 219;	11X, 13.2S, 12.7E; drilled by Germantown Artesian Well Co. in 1921; altitude 140 feet.		
	Clay, yellow	100	100
	Clay, blue	23	123
	Gravel, medium	4	127
	Shale, gray soft	14	141
Cb 389;	12Y, 2.6S, 5.3E; drilled by Germantown Artesian Well Co. in 1937; altitude 540 feet.		
	Soil	1	1
	Clay mixed with hardpan	26	27
	Shale rock	41	68
	Quartzite	10	78
	Shale rock	22	100
Cb 598;	12X, 9.8S, 9.5E; drilled by H. McLean; altitude 190 feet.		
	Soil	10	10
	Clay, yellow	10	20
	Gravel and quicksand	130	150
	Gravel, clean	7	157
Cb 665;	12Y, 7.7S, 3.6E; drilled by H. McLean in 1945; altitude 750 feet.		
	Hardpan and boulders	123	123
	Slate, black	73	196
Cb 682;	12Y, 8.3S, 4.4E; drilled by H. McLean; altitude 620 feet.		
	Hardpan and boulders	240	240
	Slate, with calcite and quartzite streaks	210	450

Table 5.—Drillers' logs of selected wells in Columbia County, N. Y. (Concluded)

		Thickness (feet)	Depth (feet)
Cb 697;	12Y, 7.2S, 12.1E; drilled by Goold Bros. in 1944; altitude 720 feet.		
	Hardpan	16	16
	Limestone	60	76
	Flint rock	2	78
	Limestone	19	97
Cb 698;	12Y, 7.1S, 12.5E; drilled by H. McLean in 1941; altitude 900 feet.		
	Hardpan and boulders	121	121
	Sand	2	123
	Rock at	..	123
Cb 733;	12Y, 9.9S, 10.5E; drilled well; altitude 550 feet.		
	Gravel	10	10
	Sand and muck	8	18
	Shell marl	3	21
	Clay	35	56
	Gravel at	..	56
Cb 741;	12Y, 13.7S, 11.9E; drilled by H. McLean; altitude 780 feet.		
	Clay	90	90
	Sand, fine, yellow	88	178
	Limestone	26	204
Cb 852;	11X, 17.3S, 10.2E; drilled by the Germantown Artesian Well Co.; altitude 8 feet.		
	Clay, blue	110	110
	Shale	690	800
	Limestone	208	1,008
Cb 855;	11Y, 7.1S, 3.1E; drilled by Hall and Co., Inc., in 1947; altitude 200 feet.		
	Sand and red clay loam	13	13
	Gravel, coarse, and some sand	21	34
	Sand, medium black	1	35
Cb 862;	11Y, 6.4S, 3.3E; drilled by W. Shaver; altitude 210 feet.		
	Topsoil	2	2
	Gravel	8	10
	Clay, sandy	30	40
	Sand, fine	5	45
	Sand, coarse	5	50
	Rock at	..	50

Table 6.—Records of selected wells in Columbia County, New York

Location: For explanation of location symbols see section "Methods of investigation."
Altitude above sea level: Approximate altitude from topographic map.
Type of well: Drl, drilled; Drv, driven.

Water level below land surface: Reported average water level.
Method of lift: For explanation of methods of lift and pumping equipment see section "Recovery."
Use: Com, commercial; Dom, domestic; Ind, industrial; PWS, public water supply.

Well number	Location	Owner	Altitude above sea level (feet)	Type of well	Depth (feet)	Diameter (inches)	Depth to bedrock (feet)	Geologic subdivision	Water level below land surface (feet)	Method of lift	Yield (gallons per minute)	Use	Remarks
Cb 2	12Y, 14.9N, 0.2W	Schrodt Bros.	260	Drl	203	6	67	Schodack formation	43	Force	1	Farm	
Cb 5	11Y, 3.3S, 0.8E	Gibson & Son	230	Drl	90	6	20	do.	13	Jet	2.5	Farm	
Cb 7	11Y, 2.5S, 2.6E	Ray Mitchel	280	Drl	162	6	87	do.	30	Force	.8	Farm	
Cb 12	11Y, 3.2S, 3.3E	Ralph & Harry Stahlman	320	Drl	90	6	90	Pleistocene gravel	18	Suction	6	Farm	Reportedly no drawdown.[b]
Cb 13	11Y, 3.0S, 4.3E	Ralph Dudley	340	Drl	195	6	21	Schodack formation	17	Jet	9	Ind	For cold-storage plant; drawdown reported 91 feet. Temperature of water 42° F., October 1947.[a]
Cb 15	11Y, 2.7S, 4.5E	do.	400	Drl	352	6	165	do.	104	Force	2	Dom	Drawdown reported to be 98 feet.
Cb 20	11Y, 1.9S, 6.1E	Sheffield Farms	360	Drv	20	2	...	Pleistocene sand	16	Centrifugal	..	Ind	For milk plant; average pumpage 2,500 gallons per day. Temperature 50° F., January 1945.[a b]
Cb 22	11Y, 1.8S, 10.6E	A. Zitterwald	660	Drl	59	6	50	Rensselaer graywacke	50	Force	2	Dom	
Cb 23	11Y, 2.0S, 12.3E	D. G. Thomson	1,130	Drl	113	6	57	Normanskill shale	24	do.	4	Farm	
Cb 24	12Y, 16.0N, 0.1W	Stephen Arto	1,000	Drl	104	6	6	do.	..	None	2	Farm	Flowing well.
Cb 27	11Z, 1.1S, 1.6E	George French	640	Drl	107	6	6	do.	20	Jet	4	Dom	Drawdown reported to be 40 feet.
Cb 28	11Z, 0.8S, 2.4E	H. B. Hicks	700	Drl	58	6	7	do.	2	Suction	10	Dom	
Cb 30	11Z, 1.9S, 4.1E	L. D. Parker	760	Drl	700	6	...	do.	..	Force	..	Dom	Temperature 47° F., November 1945.[a]
Cb 33	11Z, 2.3S, 4.3E	Dr. Lancaster	700	Drl	102	6	21	do.	4	Suction	2.5	Dom	Drawdown reported to be 19 feet; originally flowed at 0.5 gallon per minute.
Cb 35	11Z, 1.8S, 4.8E	Samuel Watkinson	760	Drl	43	6	...	Pleistocene deposits	9	do.	3.5	Dom	Finished with 5 feet of 4-inch screen. Lead packer used at depth of 38 feet.
Cb 37	11Z, 1.8S, 5.7E	Stanley Chittenden	760	Drl	88	6	80	Normanskill shale	15	Jet	7	Farm	Drawdown reported to be 65 feet.
Cb 39	11Z, 2.4S, 5.4E	The Tilden Co.	730	Dug	6	120	...	Pleistocene gravel	+2	Suction	125	Ind	Flowing well; average pumpage 2,500 gallons per day. Temperature 54° F., November 1945.[a]
Cb 40	11Z, 2.2S, 5.5E	G. A. Sticht	730	Drl	131	4½	98	Stockbridge limestone	10	Force	1	Dom	Drawdown reported to be 121 feet.[b]
Cb 43	11Z, 1.6S, 6.3E	Lebanon Central High School	780	Drl	58	8	16	do.	14	Suction	40	Dom	
Cb 44	11Z, 4.4S, 5.1E	Dr. R. Alexander	880	Drl	32	6	10	do.	8	Centrifugal	30	Dom	Temperature is 48° F., October 1945.
Cb 45	11Z, 4.1S, 3.8E	Lewis Murdock	1,040	Drl	193	6	20	do.	12	Force	1.5	Dom	Limestone rock very hard.
Cb 46	11Y, 4.0S, 9.6E	G. Hennig	560	Drl	233	6	146	Nassau formation	42	do.	.2	Dom	
Cb 47	11Y, 4.6S, 8.9E	J. S. Williams	460	Drl	120	6	8	do.	18	do.	15	Farm	Drawdown reported to be 62 feet; water reported to contain hydrogen sulfide.
Cb 53	11Y, 3.9S, 6.4E	Dr. C. Hacker	440	Drl	85	6	19	do.	9	Suction	16	Dom	
Cb 55	11Y, 3.6S, 5.2E	Mike Hover	350	Drl	85	4	25	do.	18	Force	3	Dom	

See footnotes at end of table.

Table 6.—Records of selected wells in Columbia County, New York (Continued)

Well number	Location	Owner	Altitude above sea level (feet)	Type of well	Depth (feet)	Diameter (inches)	Depth to bedrock (feet)	Geologic subdivision	Water level below land surface (feet)	Method of lift	Yield (gallons per minute)	Use	Remarks
Cb 59	11Y, 4.5S, 4.7E	Standard Oil Co.	300	Drl	40	1¼	...	Pleistocene sand	15	Force	15	Com	Well abandoned. First 20 feet drilled with a 6-inch-diameter bit; last 20 feet driven with a 1¼-inch-diameter pipe.
Cb 61	11Y, 5.8S, 4.5E	Abraham Mitchell	280	Drl	45	4	45	Pleistocene sand and gravel	20	Suction	10	Farm	Reportedly no drawdown after pumping for 2 hours.[b]
Cb 63	11Y, 4.5S, 4.0E	Wassaic State School	300	Dug	20	48	20	Pleistocene sand	16	do.	115	Farm	Temperature 52° F., October 1945.[a]
Cb 66	11Y, 3.7S, 4.2E	Paul Winslow	320	Drl	82	6	10	Schodack formation	29	Force	6	Dom	
Cb 67	11Y, 3.8S, 3.3E	Davidson Bros.	310	Drl	156	6	106	do.	14	Jet	11	Ind	Drawdown reported to be 16 feet; temperature 50° F., November 1945.
Cb 68	11Y, 4.0S, 3.3E	Davidson Bros.	310	Drl	100	6	100	Pleistocene gravel	20	Suction	21	Farm	Drawdown reported to be 1 foot after pumping 6 hours.[b]
Cb 69	11Y, 4.6S, 3.0E	Dudley Myers	300	Drl	70	6	70	do.	15	Centrifugal	25	Ind	10,000 gallons per day used for cold-storage plant during September and October. Temperature 52° F., October 1945.[b]
Cb 72	11Y, 5.0S, 3.1E	E. Pross	300	Drl	136	6	...	Pleistocene sand	63	Force	2.5	Dom	
Cb 74	11Y, 5.7S, 2.2E	J. B. Loyds	260	Drl	238	4	26	Normanskill shale	26	do.	1	Dom	Temperature 50° F., November 1945.
Cb 75	11Y, 5.2S, 2.3E	J. Davenport	280	Drl	138	6	138	Pleistocene gravel	20	do.	10	Farm	Supplies three households.
Cb 77	11Y, 4.4S, 2.3E	Dahlgren Bros.	280	Dug	25	60	...	Pleistocene sand and gravel	18	do.	25	Farm	
Cb 78	11Y, 5.1S, 1.9E	Spencer Hinds	220	Drl	161	6	123	Nassau formation	55	Jet	7	Farm	Drawdown reported to be 5 feet.
Cb 79	11Y, 5.4S, 1.8E	J. B. Loyds	200	Drl	185	4½	75	Schodack formation	32	Force	.7	Farm	Water reported to contain hydrogen sulfide.
Cb 80	11Y, 5.1S, 0.9E	George Leiser	240	Drl	88	6	6	do.	17	do.	6	Farm	
Cb 82	11Y, 5.7S, 0.3E	Fred Keene Estate	240	Drl	95	6	7	do.	10	do.	6	Farm	
Cb 83	12Y, 13.1N, 0.3W	W. K. Crouthamel	220	Drl	127	6	23	do.	27	do.	1	Dom	([b])
Cb 84	11Y, 7.1S, 1.4E	A. Ogden	260	Drl	124	6	40	Nassau formation	36	do.	15	Farm	Supplies a 50,000-gallon swimming pool during the summer.
Cb 85	11Y, 8.2S, 1.4E	Dr. Dwight Smith	220	Drl	295	6	92	do.	27	do.	5	Dom	Originally 160 feet deep, but deepened after original yield failed.
Cb 86	11Y, 7.3S, 2.0E	Kinderhook Fruit Co.	260	Drl	196	8	120	do.	125	do.	10	Ind	
Cb 87	11Y, 7.0S, 2.3E	Echo Fruit Farm	260	Drl	87	6	80	do.	37	do.	30	Ind	29,000 gallons per day used in cold-storage plant during September and October. Temperature 50° F., November 1945.
Cb 89	11Y, 6.3S, 2.2E	E. O. Dorman	278	Drl	119	6	37	do.	21	do.	15	Farm	Drawdown reported to be 79 feet.
Cb 90	11Y, 6.0S, 2.4E	Roy McVaugh	280	Drl	193	6	108	do.	85	Jet	3	Farm	([b])
Cb 91	11Y, 7.1S, 3.1E	Village of Kinderhook	200	Drl	31	8	...	Recent gravel	12	Suction	150	PWS	Finished with 5 feet of 8-inch screen; drawdown reported to be half an inch after pumping 12 hours at 150 gallons per minute.[a]

See footnotes at end of table.

Table 6.—Records of selected wells in Columbia County, New York (Continued)

Well number	Location	Owner	Altitude above sea level (feet)	Type of well	Depth (feet)	Diameter (inches)	Depth to bedrock (feet)	Geologic subdivision	Water level below land surface (feet)	Method of lift	Yield (gallons per minute)	Use	Remarks
Cb 97	11Y, 8.7S, 1.7E	J. E. Van Alstyne	200	Drl	87	6	74	Normanskill shale	57	Force	50	Ind	Temperature 55° F., October 1945.
Cb 98	11Y, 7.6S, 3.3E	J. C. Hand	280	Drl	155	6	12	Nassau formation	12	do.	3	Dom	
Cb 102	11Y, 6.0S, 4.6E	Walter Garrigan	280	Drl	108	4	15	do.	25	do.	4	Dom	
Cb 104	11Y, 7.5S, 4.8E	Dick McCagg	300	Drl	80	6	...	do.	12	do.	4	Farm	Drawdown reported to be 28 feet.
Cb 105	11Y, 7.1S, 5.4E	W. S. Crandall	300	Drl	280	6	25	do.	..	do.	9	Farm	Temperature 43° F., January 1948.[a]
Cb 106	11Y, 7.3S, 11.4E	Helen Lavelle	820	Drl	236	6	18	Normanskill shale	16	do.	1.5	Dom	
Cb 107	11Z, 5.4S, 2.0E	Albany Fresh Air Guild for Children	840	Drl	110	6	45	do.	18	..	6	Dom	Drawdown reported to be 12 feet.
Cb 110	11Z, 6.1S, 2.6E	Canaan Village School District	840	Drl	139	6	18	do.	6	..	8	Dom	Drawdown reported to be 44 feet.
Cb 111	11Z, 6.4S, 3.4E	F. Tompkins	900	Drl	49	6	...	Pleistocene gravel	13	Jet	5	Dom	Drawdown reported to be 27 feet after pumping for 3 weeks.
Cb 113	11Z, 6.5S, 3.8E	Charles Lorents	1,100	Drl	236	6	11	Stockbridge limestone	100	Force	1.3	Dom	
Cb 115	11Z, 6.8S, 4.1E	A. H. Miller	1,075	Drl	87	6	24	do.	27	..	10	Dom	Drawdown reported to be 33 feet after pumping for 2 hours.
Cb 119	11Z, 5.9S, 5.0E	Berkshire Industrial Farm School	1,060	Drv	19	2	...	Pleistocene gravel	..	Suction	..	Dom	Average pumpage, 16,000 gallons per day from total of five similar wells.
Cb 120	11Z, 8.0S, 4.1E	R. E. Dunton	1,075	Drl	83	6	6	Stockbridge limestone	30	Force	.1	Dom	
Cb 121	11Z, 9.2S, 2.6E	Guy Payn	980	Drl	73	6	10	do.	8	..	20	Farm	Drawdown reported to be 10 feet.[b]
Cb 122	11Z, 8.2S, 2.0E	Deutsch Farm	900	Drl	240	6	11	do.	32	Force	11	Farm	Drawdown reported to be 98 feet.
Cb 124	11Y, 8.6S, 9.7E	Harry Sherman	720	Drl	120	6	19	Normanskill shale	45	do.	1.8	Farm	
Cb 125	11Y, 8.3S, 9.0E	Columbia Box Board	520	Drl	99	6	13	do.	15	..	3.5	Dom	Drawdown reported to be 65 feet.
Cb 126	11Y, 8.8S, 6.6E	E. Strever	360	Drl	250	6	30	Nassau formation	75	Force	30	Farm	
Cb 127	11Y, 8.0S, 5.6E	Hugh McClellan	340	Drl	71	6	12	do.	19	Suction	10	Dom	Reportedly no drawdown.[b]
Cb 129	11Y, 8.9S, 4.2E	Morris Wolder	340	Drl	60	6	0	do.	10	Force	3.5	Dom	Water reported to contain hydrogen sulfide.
Cb 130	11Y, 8.4S, 3.8E	Fred Benhofft	440	Drl	90	6	20	do.	20	do.	1.3	Farm	
Cb 132	11Y, 8.4S, 3.0E	Ichabod Crane School	260	Drl	100	6	71	do.	40	do.	.8	Farm	
Cb 133	11Y, 8.8S, 3.3E	Eugene Peruzz	360	Drl	50	6	1	do.	12	do.	2	Dom	Water reported to be cloudy after a rainstorm.
Cb 134	11Y, 9.4S, 3.3E	Edwin Simonsen	440	Drl	50	6	12	do.	10	do.	2	Dom	Drawdown reported to be 40 feet.
Cb 136	11Y, 9.2S, 2.7E	Ernest Hoes	280	Drl	157	6	43	do.	40	do.	12	Farm	
Cb 138	11Y, 10.0S, 1.0E	Harlan Rockefeller	200	Drl	84	6	42	Normanskill shale	20	do.	2	Dom	Water reported to contain hydrogen sulfide.[a]
Cb 139	11Y, 10.2S, 1.1E	Y. Heinz	200	Drl	99	6	86	do.	11	Suction	3	Dom	Reported no drawdown after pumping 7 hours.
Cb 141	11Y, 9.7S, 0.3E	George Byfonski	220	Drl	65	6	29	do.	22	do.	3.5	Dom	([b])

See footnotes at end of table.

Table 6.—Records of selected wells in Columbia County, New York (Continued)

Well number	Location	Owner	Altitude above sea level (feet)	Type of well	Depth (feet)	Diameter (inches)	Depth to bedrock (feet)	Geologic subdivision	Water level below land surface (feet)	Method of lift	Yield (gallons per minute)	Use	Remarks
Cb 142	12Y, 8.5N, 0.6W	H. Allen	100	Drl	195	6	77	Nassau formation	24	Force	5	Farm	Drawdown reported to be 111 feet. Water reported to contain iron and hydrogen sulfide.
Cb 146	12Y, 10.1N, 1.7W	Odd Fellows Home	120	Drl	475	8	100	Normanskill shale	135	do.	3.5	Dom	
Cb 150	12Y, 9.5N, 1.9W	Stuyvesant Catholic Church	100	Drl	165	6	...	Pleistocene gravel	128	do.	1	Dom	
Cb 152	12Y, 9.1N, 1.9W	V. K. Mc Elhenny	20	Drl	240	6	74	Schodack formation	9	Suction	5.6	Dom	
Cb 153	12Y, 8.2N, 1.8W	Howard Fingar	200	Drl	600	6	186	Normanskill shale	125	Force	2	Farm	Well abandoned owing to high content of hydrogen sulfide in water.
Cb 156	12Y, 7.3N, 1.8W	C. Ross	20	Drl	112	6	76	Nassau formation	20	do.	1	Dom	
Cb 157	12Y, 9.7N, 0.6W	Ralph Thomas	100	Drl	319	4	275	do.	50	do.	3	Farm	Drawdown reported to be 100 feet; water cloudy.
Cb 158	11Y, 9.7S, 0.9E	Charles Frisbee	200	Drl	91	8	50	Normanskill shale	..	do.	2.5	Dom	Water reported to contain hydrogen sulfide.
Cb 159	11Y, 9.5S, 1.5E	J. S. Hand	220	Drv	15	1¼	...	Pleistocene sand and gravel	..	Suction	3	Farm	
Cb 162	12Y, 9.9N, 1.2W	Arthur Calkins	160	Drl	160	6	118	Schodack formation	78	Force	3	Com	
Cb 164	11Y, 2.8S, 1.1W	John Van Eyk	100	Drl	132	6	48	Normanskill shale	..	do.	1	Dom	
Cb 167	11Y, 10.1S, 2.8E	J. Freeman	330	Drl	212	6	20	Nassau formation	14	do.	.75	Dom	
Cb 168	11Z, 0.5S, 5.7E	West Acres Trading Corp.	1,000	Drl	108	8	10	Normanskill shale	+1	do.	6	Dom	Flowing well; flows 1 gallon per minute. Drawdown reported to be 101 feet when pumping at 6 gallons per minute.
Cb 169	11Z, 2.7S, 2.4E	Donald Flanders	900	Drl	135	6	95	do.	22	do.	3	Farm	
Cb 171	11Y, 6.7S, 12.5E	Antoni Suvoviec	700	Drl	104	6	54	Normanskill shale	..	Jet	5.5	Farm	Flowing well; drawdown reported to be 60 feet when pumping at 5.5 gallons per minute.
Cb 172	11Y, 5.5S, 12.2E	C. E. Heyl	740	Drl	115	6	17	do.	15	do.	3	Dom	Drawdown reported to be 30 feet.
Cb 173	11Y, 4.8S, 12.1E	Felix Smith	900	Drl	225	6	112	do.	115	Force	3	Farm	
Cb 174	11Y, 2.3S, 11.0E	C. Adler	760	Drl	64	6	8	Rensselaer graywacke	..	Jet	..	Dom	Temperature 50° F., December 1947.[a]
Cb 175	11Y, 2.4S, 10.9E	School District No. 8	750	Drl	68	6	11	do.	12	Force	2.5	Dom	Drawdown reported to be 48 feet.
Cb 179	11Y, 6.8S, 11.4E	J. Koller	800	Drl	170	6	123	Normanskill shale	38	do.	5	Dom	Drawdown reported to be 82 feet.
Cb 180	11Y, 7.0S, 11.2E	Allen O'Hara	800	Drl	129	6	10	do.	40	do.	3	Dom	Drawdown reported to be 40 feet.
Cb 182	11Y, 8.7S, 10.2E	Fred Popons	650	Drl	139	6	87	do.	..	Jet	4.5	Dom	Flowing well; drawdown reported to be 100 feet when pumping at 4.5 gallons per minute.
Cb 183	11Y, 7.8S, 9.5E	Richard Van Houten	560	Drl	202	6	40	do.	29	Force	4.5	Dom	
Cb 184	11Y, 9.5S, 8.4E	Wright Westover	600	Drl	72	8	7	do.	12	Suction	9	Dom	Drawdown reported to be 30 feet.
Cb 185	11Y, 8.6S, 8.1E	M. Hattersley	460	Drl	130	6	17	do.	12	..	2	Dom	Drawdown reported to be 68 feet.
Cb 188	11Y, 5.2S, 9.1E	Elsie Powell	700	Drl	203	6	19	Nassau formation	42	Force	10.5	Dom	

See footnotes at end of table.

Table 6.—Records of selected wells in Columbia County, New York (Continued)

Well number	Location	Owner	Altitude above sea level (feet)	Type of well	Depth (feet)	Diameter (inches)	Depth to bedrock (feet)	Geologic subdivision	Water level below land surface (feet)	Method of lift	Yield (gallons per minute)	Use	Remarks
Cb 190	11Y, 1.9S, 8.3E	W. A. Wood	500	Drl	165	6	105	Nassau formation	73	Jet	1.5	Dom	
Cb 191	11Y, 2.6S, 7.7E	Fred Heller	400	Drl	85	6	15	do.	15	Force	..	Farm	Water reported to contain hydrogen sulfide. Temperature 45° F., February 1947.
Cb 192	11Y, 2.7S, 7.1E	Grafton Griswold	400	Drl	70	6	6	do.	18	Suction	..	Farm	Temperature 48° F., February 1947.
Cb 194	11Y, 4.1S, 6.5E	Arthur Howard	450	Drl	60	6	6	do.	19	Force	3.5	Dom	Drawdown reported to be 9 feet.
Cb 195	11Y, 4.5S, 7.1E	Murray Giddings	440	Drl	78	6	49	do.	3	..	2.5	Farm	Drawdown reported to be 27 feet.
Cb 196	11Y, 5.5S, 7.0E	Roger Williams	300	Drl	68	6	...	Pleistocene sand	28	Force	10	Farm	
Cb 198	11Y, 7.0S, 5.6E	Kate Sommers	260	Drl	80	6	71	Nassau formation	20	Suction	30	Dom	Water reported to contain hydrogen sulfide.
Cb 200	11Y, 8.0S, 7.4E	Patrick Flood	380	Drl	97	6	51	Normanskill shale	25	Force	10	Dom	
Cb 202	11Y, 8.5S, 7.5E	Walter Mayer	380	Drl	37	6	13	do.	7	..	3	Farm	
Cb 205	12Y, 6.6N, 0.8W	Frank Simone	140	Drl	59	6	35	do.	38	Force	1	Dom	
Cb 209	12Y, 6.1N, 0.4W	Stockport School No. 3	170	Drl	164	6	...	Pleistocene sand	15	do.	1	Dom	
Cb 210	12Y, 6.0N, 0.5W	Frank Graziano	170	Drl	72	6	18	Normanskill shale	10	..	3	Dom	Drawdown reported to be 20 feet.
Cb 213	12Y, 5.6N, 0.8W	George Broadreau	140	Drv	100	6	30	Nassau formation	20	Force	1.5	Dom	Rock overlain by 30 feet of clay.
Cb 214	12Y, 5.6N, 0.4W	William Stevens	170	Drl	50	6	14	Normanskill shale	25	do.	6	Dom	Drawdown reported to be 15 feet.
Cb 216	12Y, 5.3N, 0.2W	Walter Leach	140	Drl	75	6	57	do.	40	do.	4	Dom	
Cb 218	12Y, 4.9N, 0.5W	Joseph Wood	120	Drl	159	6	115	Nassau formation	101	do.	.5	Dom	([b])
Cb 219	12Y, 4.3N, 0.3W	Charles Van de Carr	140	Drl	241	6	127	do.	64	do.	.6	Dom	Water reported to be cloudy.[b]
Cb 220	12Y, 2.9N, 1.3W	Charles Saurus	100	Drl	218	6	80	do.	60	do.	.5	Farm	Water reported to be milky. Temperature 51° F., July 1946.[a]
Cb 221	12Y, 3.0N, 0.3W	George Sutherland Estate	230	Drl	85	6	20	do.	15	do.	18	Farm	Reportedly no drawdown after pumping 2 hours.
Cb 225	11Y, 14.8S, 0.5E	Gardiner's Ice Cream Co.	120	Drl	80	6	47	do.	0	..	30	Ind	Drawdown reported to be 22 feet. Average pumpage, 1,800 gallons per day.
Cb 226	11Y, 14.7S, 0.3E	Fred J. George	150	Drl	68	6	10	do.	5	Suction	3.5	Com	Drawdown reported to be 21 feet.
Cb 228	11Y, 14.3S, 0.7E	Atlantic Mills	60	Drl	1,056	8	55	Normanskill shale	..	None	5	Ind	Well not in use; originally a flowing well; water reported to contain hydrogen sulfide.
Cb 230	11Y, 13.8S, 0.2E	M. Myers	200	Drl	47	6	0	Nassau formation	..	Force	1	Dom	
Cb 232	11Y, 13.3S, 0.2E	C. Latorre	140	Drl	363	6	80	Normanskill shale	75	do.	1.5	Dom	
Cb 233	11Y, 12.5S, 0.3E	Frank Meltz	40	Drl	69	6	10	do.	..	Suction	8.5	Dom	Reported to contain hydrogen sulfide.
Cb 234	11Y, 11.8S, 0.4E	John Berhens	100	Drl	142	6	18	do.	15	..	4	Dom	Drawdown reported to be 85 feet.
Cb 235	11Y, 11.1S, 1.2E	E. Miller	200	Drl	90	6	0	do.	2	Force	2	Dom	
Cb 237	11Y, 9.9S, 0.4E	Henry Hubbell	200	Drl	120	6	15	do.	15	do.	1.5	Com	

See footnotes at end of table.

Table 6.—Records of selected wells in Columbia County, New York (Continued)

Well number	Location	Owner	Altitude above sea level (feet)	Type of well	Depth (feet)	Diameter (inches)	Depth to bedrock (feet)	Geologic subdivision	Water level below land surface (feet)	Method of lift	Yield (gallons per minute)	Use	Remarks
Cb 238	11Y, 10.9S, 2.5E	Herbert Fingar	240	Drl	307	6	32	Nassau formation	..	Force	3	Farm	
Cb 239	11Y, 11.6S, 2.7E	Edward Coon	270	Drl	33	6	12	do.	12	..	7.5	Farm	
Cb 241	11Y, 12.2S, 2.6E	Mary Widmayer	240	Drl	73	6	36	do.	10	Force	14	Dom	Drawdown reported to be 19 feet.
Cb 244	11Y, 13.3S, 2.3E	S. Tottville	200	Drl	123	6	7	do.	7	Jet	3	Dom	Drawdown reported to be 68 feet.
Cb 246	11Y, 13.7S, 2.0E	Leroy Gardner	200	Drl	180	6	17	do.	21	Force	5	Farm	Drawdown reported to be 111 feet.
Cb 248	11Y, 14.3S, 1.7E	Joseph Parker	200	Drl	57	..	16	do.	13	..	10	Dom	Drawdown reported to be 11 feet.
Cb 254	11Y, 15.2S, 3.7E	Howard Ostrander	330	Drl	40	4½	11	do.	12	Force	2	Farm	
Cb 256	11Y, 14.0S, 4.0E	J. W. Hagnitz	350	Drl	104	6	19	do.	20	do.	4.5	Dom	Drawdown reported to be 55 feet.
Cb 257	11Y, 13.9S, 4.0E	Mae Poole	350	Drl	93	6	17	do.	20	do.	3.5	Dom	Drawdown reported to be 25 feet.
Cb 259	11Y, 12.0S, 3.6E	Irwin Kittle	300	Drl	147	6	15	do.	12	..	5	Farm	Drawdown reported to be 63 feet.
Cb 260	11Y, 11.0S, 5.0E	A. J. Foresten	400	Drl	80	6	33	do.	10	..	4	Dom	Drawdown reported to be 14 feet.
Cb 262	11Y, 12.8S, 5.0E	Charles Schmidt	360	Drl	62	6	21	do.	23	Force	4.5	Farm	Drawdown reported to be 1 foot.
Cb 263	11Y, 13.1S, 4.9E	E. Reidmiller	360	Drl	95	6	8	do.	30	do.	3	Farm	Drawdown reported to be 20 feet.
Cb 264	11Y, 15.0S, 4.8E	J. Phiffer	280	Drv	18	1¼	...	Pleistocene sand	15	Suction	3	Farm	
Cb 265	11Y, 15.3S, 4.5E	Fred Winters	300	Drl	58	6	17	Nassau formation	6	..	4.5	Dom	Drawdown reported to be 18 feet.
Cb 267	11Y, 16.0S, 4.5E	Frank Stark	280	Drl	75	6	43	do.	16	Suction	10	Farm	Slight drawdown reported after pumping 1 hour.
Cb 268	11Y, 16.1S, 5.2E	William Ross	300	Drl	52	6	15	do.	4	do.	2	Dom	
Cb 271	11Y, 13.8S, 5.9E	Harry Nash	320	Drl	57	6	24	do.	17	..	25	Farm	Drawdown reported to be 9 feet. Temperature 48° F., October 1945.
Cb 273	11Y, 12.9S, 6.3E	Philip Fuss	340	Drl	56	6	12	Normanskill shale	14	..	3	Dom	Drawdown reported to be 9 feet.
Cb 274	11Y, 12.1S, 6.6E	Goold Bros.	400	Drl	162	6	21	do.	21	Force	7.5	Dom	Drawdown reported to be 59 feet.
Cb 279	11Y, 11.8S, 6.9E	Ghent Village School	400	Drl	142	6	20	do.	12	do.	6	Dom	
Cb 282	11Y, 9.3S, 5.9E	Rudolph Nichols	340	Drl	82	6	15	Nassau formation	15	Suction	5	Dom	
Cb 283	11Y, 9.5S, 6.9E	John Craft	460	Drl	178	6	31	Normanskill shale	11	..	8	Ind	Drawdown reported to be 89 feet.
Cb 285	11Y, 9.7S, 7.2E	E. Finkle	460	Drl	103	6	13	do.	13	Suction	1.5	Dom	
Cb 286	11Y, 9.6S, 7.5E	Incorporated village of Chatham	420	Drl	70	8	...	Pleistocene gravel	..	do.	..	PWS	Finished with screen. Together with Cb 287 produces an average of 350,000 gallons per day.
Cb 287	11Y, 9.6S, 7.5E	do.	420	Drl	65	8	...	do.	..	do.	..	PWS	Finished with screen.
Cb 289	11Y, 15.0S, 7.1E	C. Shnackenberg	680	Drl	61	6	11	Normanskill shale	3	..	5.5	Dom	Drawdown reported to be 20 feet.
Cb 292	11Y, 14.4S, 7.4E	School District No. 2	680	Drl	58	6	38	do.	12	Force	15	Dom	
Cb 293	11Y, 15.2S, 7.7E	R. Lighton	760	Drl	178	6	12	do.	9	..	7	Farm	Drawdown reported to be 89 feet.
Cb 294	11Y, 16.6S, 6.8E	C. Albright	680	Drl	100	6	5	do.	17	Force	4.5	Dom	Drawdown reported to be 32 feet.

See footnotes at end of table.

Table 6.—Records of selected wells in Columbia County, New York (Continued)

Well number	Location	Owner	Altitude above sea level (feet)	Type of well	Depth (feet)	Diameter (inches)	Depth to bedrock (feet)	Geologic subdivision	Water level below land surface (feet)	Method of lift	Yield (gallons per minute)	Use	Remarks
Cb 295	11Y, 14.4S, 8.5E	Jacob Schott	860	Drl	106	6	15	Normanskill shale	21	Jet	2.8	Farm	Drawdown reported to be 39 feet.
Cb 297	11Y, 15.5S, 10.5E	C. S. Dohoney	1,120	Drl	175	6	8	do.	21	Force	3.5	Dom	Drawdown reported to be 64 feet.
Cb 305	11Y, 12.7S, 11.0E	G. H. Reach	800	Drl	170	6	8	do.	10	do.	7	Farm	
Cb 306	11Y, 12.4S, 10.9E	Rose Fredericks	820	Drl	118	6	88	do.	23	do.	29	Dom	Drawdown reported to be 62 feet.
Cb 308	11Y, 12.3S, 10.6E	Spencertown Academy	720	Drl	111	6	49	do.	21	do.	15	Dom	
Cb 313	11Y, 11.3S, 8.7E	Charles Mc Intire	680	Drl	190	6	11	do.	12	do.	3.5	Dom	
Cb 315	11Y, 10.9S, 10.3E	W. J. Spence	820	Drl	300	6	0	do.	1	do.	4.5	Dom	Static head falls to 100 feet during summer.
Cb 317	11Y, 10.4S, 11.0E	May Donohue	740	Drl	151	6	15	do.	15	do.	4	Dom	Drawdown reported to be 60 feet.
Cb 319	11Y, 9.9S, 10.2E	Harry Gleason	660	Drl	100	6	30	do.	10	Jet	4	Dom	Water reported to contain hydrogen sulfide.
Cb 323	11Y, 10.3S, 9.2E	Clarence Sayles	550	Drl	217	6	38	do.	2	Force	10	Dom	Drawdown reported to be 118 feet.
Cb 325	11Y, 10.4S, 9.0E	Hiebler District School	530	Drl	216	6	50	do.	9	do.	4	Dom	Drawdown reported to be 141 feet.
Cb 326	11Z, 12.6S, 1.0E	E. R. Hathaway	1,300	Drl	120	6	5	do.	60	do.	3	Dom	
Cb 328	11Z, 12.9S, 1.2E	Carl Arp	1,240	Drl	70	6	16	do.	2	Pitcher	3	Dom	Drawdown reported to be 26 feet.
Cb 330	12Z, 2.1N, 1.3E	W. W. Steur	1,100	Drl	41	6	28	do.	10	..	42	Farm	
Cb 332	12Z, 4.6S, 0.4E	F. Lent	840	Drl	81	6	40	Stockbridge limestone	31	Force	1.5	Dom	Temperature 50° F., January 1947.[a]
Cb 334	12Y, 1.1S, 12.5E	Martin Gilmore	830	Drl	138	6	20	Normanskill shale	..	None	1	Dom	Flowing well.
Cb 337	12Y, 0.1S, 12.6E	J. J. Mettler	880	Drl	165	6	...	do.	20	Suction	7	Farm	
Cb 339	11Y, 16.1S, 12.3E	Robert Dawson	1,080	Drl	186	6	60	do.	4	do.	6	Dom	Drawdown reported to be 116 feet.
Cb 343	11Y, 16.1S, 10.5E	Sherman Rodgers	1,100	Drl	126	6	14	do.	15	..	7	Dom	Drawdown reported to be 55 feet.
Cb 345	12Y, 1.8S, 8.3E	J. Peabody	860	Drl	130	6	21	do.	109	Force	3.5	Farm	Drawdown reported to be 11 feet.
Cb 347	12Y, 3.1S, 8.4E	H. L. Parry	760	Drl	150	6	15	do.	15	do.	15	Farm	
Cb 348	12Y, 4.0S, 7.1E	Wilbur Decker	780	Drl	140	6	10	do.	18	do.	.8	Dom	Drawdown reported to be 42 feet.
Cb 349	12Y, 4.4S, 7.0E	Martindale School	700	Drl	123	6	93	do.	8	do.	1	Dom	School is not in use at present.
Cb 352	12Y, 2.9S, 9.5E	E. Rodman & Sons	760	Drl	118	6	10	do.	+1	Suction	12	Dom	Flowing well; drawdown reported to be 61 feet when pumped at 12 gallons per minute.
Cb 354	12Y, 1.9S, 12.4E	Bernice Shutts	820	Drl	110	6	74	do.	45	Force	1	Farm	
Cb 357	12Y, 2.8S, 12.5E	G. Underhill	700	Drl	140	6	9	Stockbridge limestone	25	do.	3	Dom	
Cb 358	12Y, 3.2S, 12.5E	Henry Clark	700	Drl	86	6	19	do.	4	Suction	20	Dom	
Cb 376	12Y, 4.7S, 12.0E	Albert Moore	640	Drl	57	6	39	do.	18	do.	20	Dom	
Cb 377	12Y, 4.9S, 11.5E	George Porteons	680	Drl	137	6	53	Normanskill shale	25	Force	3	Dom	Drawdown reported to be 50 feet.

See footnotes at end of table.

Table 6.—Records of selected wells in Columbia County, New York (Continued)

Well number	Location	Owner	Altitude above sea level (feet)	Type of well	Depth (feet)	Diameter (inches)	Depth to bedrock (feet)	Geologic subdivision	Water level below land surface (feet)	Method of lift	Yield (gallons per minute)	Use	Remarks
Cb 380	12Y, 5.0S, 11.4E	Hillsdale Co-operative	680	Drl	400	8	7	Normanskill shale	30	Force	25	Ind	Drawdown reported to be 170 feet; average consumption at creamery 4,000 gallons per day. Temperature 48° F., October 1945.
Cb 384	12Y, 4.0S, 6.6E	M. Jerino	700	Drl	50	6	7	do.	4	do.	2	Dom	
Cb 385	12Y, 2.9S, 6.0E	Josephine Callahan	640	Drl	54	6	4	do.	27	do.	.3	Dom	
Cb 386	12Y, 2.9S, 5.8E	Alfred LaVanion	620	Drl	82	6	45	do.	25	do.	3	Dom	
Cb 389	12Y, 2.6S, 5.3E	Martin Donnelly	580	Drl	100	6	27	do.	15	..	1.5	Dom	(b)
Cb 390	12Y, 0.6S, 6.4E	R. D. Ives	540	Drl	129	6	78	do.	50	Force	.05	Dom	
Cb 394	11Y, 17.0S, 5.4E	Roy Shufelt	600	Drl	41	6	6	do.	9	..	.5	Dom	
Cb 396	12Y, 0.3S, 4.8E	E. Shutts	340	Drl	89	4½	37	do.	34	Force	1	Dom	
Cb 397	11Y, 16.5S, 4.0E	Herman Moritz	260	Drl	121	6	19	Nassau formation	17	..	8	Farm	
Cb 398	11Y, 16.2S, 3.8E	F. H. Cookingham	380	Drl	63	4½	7	do.	6	Force	1.5	Farm	
Cb 400	11Y, 16.8S, 4.3E	Mellenville School	320	Drl	99	4	16	do.	16	..	3.5	Dom	
Cb 401	11Y, 17.0S, 4.2E	A. Welsh	300	Drl	100	6	14	do.	16	Suction	3	Dom	Drawdown reported to be 14 feet.
Cb 409	11Y, 17.0S, 3.0E	Bertha Monthie	320	Drl	87	6	5	do.	8	..	10	Dom	Drawdown reported to be 42 feet.
Cb 415	12Y, 0.9S, 2.5E	Columbia Country Club	300	Drl	104	6	24	do.	20	Force	12	Dom	Drawdown reported to be 10 feet.
Cb 420	12Y, 1.3S, 4.2E	Rene Weigelt	560	Drl	230	6	10	Normanskill shale	..	do.	8	Farm	Flowing well.
Cb 424	12Y, 1.9S, 2.0E	Clifford Miller Estate	200	Drl	220	6	25	Nassau formation	3	do.	37	Ind	Drawdown reported to be 97 feet after pumping 10 hours.
Cb 427	12Y, 2.8S, 2.3E	E. J. Essylstyn	300	Drl	178	6	7	Normanskill shale	5	do.	34.5	Farm	
Cb 429	12Y, 3.1S, 2.9E	Clarence Goordivir	320	Drl	125	6	94	do.	15	do.	3.5	Dom	Drawdown reported to be 25 feet.
Cb 434	12Y, 2.9S, 3.3E	P. W. Wildermuth	400	Drl	69	6	14	do.	5	Suction	1.5	Dom	
Cb 435	12Y, 3.3S, 3.8E	J. Tomlin	520	Drl	135	6	8	do.	19	Force	6	Farm	
Cb 437	12Y, 5.1S, 3.9E	Paul Perl	780	Drl	149	6	51	do.	22	do.	7	Dom	
Cb 441	12Y, 4.8S, 2.3E	John Gehrt	400	Drl	100	6	0	do.	18	do.	3	Farm	Drawdown reported to be 72 feet.
Cb 442	12Y, 4.0S, 1.6E	George Finch School	340	Drl	76	6	18	do.	21	do.	3	Dom	
Cb 444	12Y, 2.9S, 1.0E	Charles Collier	220	Drl	144	6	79	Nassau formation	50	do.	5	Dom	
Cb 446	12X, 2.8S, 12.4E	J. Zitta	180	Drl	64	6	12	do.	6	..	3	Farm	Drawdown reported to be 14 feet.
Cb 448	12Y, 2.2S, 0.5E	F. Fabino	150	Drl	52	6	12	do.	15	..	3	Farm	Drawdown reported to be 12 feet.
Cb 452	12Y, 1.8S, 0.8E	H. F. Burch	210	Drl	72	6	0	do.	23	Force	2	Com	
Cb 453	12Y, 1.8S, 0.8E	Mabel Esselstyn	210	Drl	121	6	21	do.	21	do.	6	Dom	Drawdown reported to be 29 feet after pumping 4 hours.
Cb 458	12Y, 1.7S, 1.6E	E. Sciuttio	240	Drl	98	6	43	do.	32	do.	1.2	Dom	
Cb 464	12Y, 1.0S, 0.9E	Samuel Grange	240	Drl	163	6	48	do.	20	do.	5.6	Dom	Drawdown reported to be 50 feet.

See footnotes at end of table.

Table 6.—Records of selected wells in Columbia County, New York (Continued)

Well number	Location	Owner	Altitude above sea level (feet)	Type of well	Depth (feet)	Diameter (inches)	Depth to bedrock (feet)	Geologic subdivision	Water level below land surface (feet)	Method of lift	Yield (gallons per minute)	Use	Remarks
Cb 465	12Y, 0.8S, 0.9E	B. Kline	250	Drl	131	6	80	Nassau formation	31	Force	30	Farm	Drawdown reported to be 14 feet.
Cb 468	11Y, 17.1S, 1.7E	H. Boice	265	Drl	108	6	3	do.	40	do.	2	Farm	
Cb 470	11Y, 16.5S, 1.2E	Greenport Water District	180	Dug	18	360	...	Pleistocene gravel	8	Centrifugal	100	PWS	Average pumpage 65,000 gallons per day
Cb 471	11Y, 15.6S, 1.4E	George Ham	220	Drl	60	6	17	Nassau formation	8	Suction	1.8	Com	
Cb 475	12Y, 0.6N, 0.5W	Joseph Sabe	160	Drl	150	6	24	do.	12	..	30	Dom	Drawdown reported to be 39 feet after pumping 4 hours.
Cb 479	12Y, 2.1N, 0.9W	W. C. Robinson	180	Drl	128	6	21	do.	15	Force	.8	Dom	
Cb 481	12Y, 1.8N, 1.3W	M. Black	...	Drl	90	6	27	do.	18	do.	1	Dom	Drawdown reported to be 12 feet.
Cb 483	12Y, 2.9S, 3.2W	J. Mulson	180	Drl	115	6	9	Normanskill shale	15	..	6	Dom	Drawdown reported to be 16 feet.
Cb 486	12Y, 0.2N, 0.4W	Universal Match Co.	150	Drl	273	6	126	Nassau formation	10	Force	35	Ind	Well No. 1. Drawdown reported to be 175 feet; average pumpage 28,000 gallons per day. Temperature 52° F., October 1945.
Cb 487	12Y, 0.2N, 0.4W	do.	150	Drl	304	6	126	do.	18	do.	48	Ind	Well No. 2. Drawdown reported to be 162 feet; average pumpage 37,000 gallons per day, May through September. Temperature 52° F., October 1945.
Cb 494	12Y, 3.5S, 3.5W	G. N. Smith	240	Drl	100	6	17	Normanskill shale	20	do.	6	Dom	Drawdown reported to be 8 feet.
Cb 496	12Y, 3.4S, 4.6W	F. Coons	220	Drl	112	6	15	do.	18	do.	2.3	Farm	Drawdown reported to be 10 feet.
Cb 502	12Y, 1.8S, 2.1W	M. Price	220	Drl	257	6	21	do.	35	do.	10	Farm	
Cb 503	12Y, 2.7S, 2.3W	M. Gannon	200	Drl	96	6	0	do.	30	do.	2	Dom	
Cb 505	12Y, 3.4S, 1.7W	J. Nahlik	200	Drl	89	6	18	Schodack formation	10	Jet	5	Com	
Cb 511	12Y, 4.1S, 0.3W	G. Hildebrandt	170	Drl	170	6	37	Nassau formation	20	Force	2	Dom	Drawdown reported to be 150 feet.
Cb 514	12Y, 4.4S, 0.9W	H. S. Case	200	Drl	160	6	107	do.	45	do.	30	Dom	Drawdown reported to be 15 feet.
Cb 516	12Y, 4.0S, 2.0W	Clarence Gardner	240	Drl	169	6	82	Schodack formation	79	do.	4	Farm	Drawdown reported to be 41 feet.
Cb 517	12Y, 3.7S, 2.0W	J. De Peyster	200	Drl	210	6	200	do.	45	do.	15	Dom	Drawdown reported to be 55 feet.
Cb 518	12Y, 3.1S, 2.4W	W. N. Fleming	200	Drl	136	6	46	Normanskill shale	50	do.	2	Dom	
Cb 521	12Y, 3.3S, 3.8W	Lewis Hotaling	220	Drl	45	6	7	do.	13	do.	1	Farm	
Cb 522	12Y, 2.9S, 3.4W	Joseph Millman	200	Drl	220	6	119	do.	5	do.	35	Ind	Static level has dropped to 12 feet below land surface and yield has declined considerably since well was completed in 1943. Temperature 50° F., October 1945.
Cb 525	12Y, 15.3S, 3.7W	Conway Bros.	200	Drl	163	6	50	do.	20	do.	4.5	Dom	Drawdown reported to be 16 feet.
Cb 526	12Y, 1.8S, 3.8W	M. Kostenbaum	260	Drl	211	6	20	do.	42	do.	4	Com	
Cb 535	12Y, 5.8S, 6.4W	John Schmidt	140	Drl	105	6	17	do.	25	do.	30	Dom	
Cb 539	12Y, 6.6S, 7.0W	M. Johansson	120	Drl	62	6	4	do.	24	do.	2.5	Dom	

See footnotes at end of table.

Table 6.—Records of selected wells in Columbia County, New York (Continued)

Well number	Location			Owner	Altitude above sea level (feet)	Type of well	Depth (feet)	Diameter (inches)	Depth to bedrock (feet)	Geologic subdivision	Water level below land surface (feet)	Method of lift	Yield (gallons per minute)	Use	Remarks
Cb 540	12Y,	6.9S,	7.0W	H. Flach	160	Drl	135	..	20	Normanskill shale	32	Force	30	Dom	Drawdown reported to be 23 feet after pumping for 4 hours.
Cb 542	12Y,	7.5S,	6.9W	Marshall Davis	200	Drl	186	6	20	do.	50	do.	5	Dom	Drawdown reported to be 30 feet.
Cb 546	12Y,	8.0S,	7.8W	Hudson Valley Cold Storage Co.	40	Drl	170	8	0	do.	8	None	1	Ind	Well not in use.
Cb 560	12Y,	8.9S,	7.3W	Herman Heins	220	Drl	66	6	9	do.	36	Force	30	Dom	Water reported to contain hydrogen sulfide.
Cb 561	12Y,	9.0S,	7.6W	J. Lackey	200	Drl	101	6	7	do.	12	Suction	8	Dom	Drawdown reported to be 48 feet after pumping for 4 hours.
Cb 564	12Y,	10.3S,	6.1W	R. H. Lasher	220	Drl	100	6	10	do.	11	..	4.5	Farm	
Cb 565	12Y,	10.6S,	5.5W	John Czajka	200	Drl	75	6	12	Schodack formation	15	Force	6	Farm	Drawdown reported to be 45 feet after pumping for 4 hours.
Cb 567	12Y,	9.5S,	6.5W	W. M. Ryan	220	Drl	168	..	33	do.	53	do.	3.5	Dom	
Cb 568	12Y,	9.4S,	5.7W	James Knight	240	Drl	87	6	28	do.	22	Jet	2	Dom	Temperature 52° F., October 1945.[a]
Cb 570	12Y,	6.9S,	5.2W	Arnold Helsley	150	Drl	77	6	8	Normanskill shale	23	Force	2	Dom	
Cb 571	12Y,	5.4S,	5.5W	Joseph Supinos	140	Drl	252	6	240	do.	50	do.	3.5	Dom	
Cb 572	12Y,	5.5S,	4.8W	Harold Holsapple	160	Drl	117	6	32	do.	18	Suction	5	Dom	Drawdown reported to be 17 feet after pumping for 4 hours.
Cb 576	12Y,	4.7S,	5.2W	Henry Tratneck	120	Drl	140	6	70	do.	25	Force	5	Com	Water reported to contain hydrogen sulfide.[a]
Cb 579	12Y,	6.8S,	1.6W	Frank Haas	180	Drl	221	6	156	Schodack formation	4	..	10	Farm	Drawdown reported to be 46 feet.
Cb 581	12Y,	4.1S,	4.3W	John Fix	260	Drl	73	6	20	Normanskill shale	25	Force	6	Farm	Drawdown reported to be 48 feet.
Cb 583	12Y,	4.7S,	3.4W	M. Bottari	300	Drl	58	6	22	do.	28	do.	1	Dom	
Cb 586	12Y,	5.2S,	3.7W	Blue Hill School	270	Drl	30	6	7	do.	10	do.	5	Dom	
Cb 587	12Y,	5.9S,	2.9W	Olav Olsen	260	Drl	111	6	9	Schodack formation	16	..	2	Dom	Drawdown reported to be 95 feet after pumping for 4 hours.
Cb 590	12Y,	6.3S,	4.1W	A. Bartolotta	260	Drl	70	6	8	do.	4	Suction	4.5	Farm	Drawdown reported to be 24 feet.
Cb 592	12Y,	7.1S,	4.1W	A. S. Ross	160	Drl	175	6	56	Normanskill shale	27	Force	8	Dom	Drawdown reported to be 30 feet; water reported to contain hydrogen sulfide.
Cb 594	12Y,	8.5S,	3.8W	Alfred Schroeder	200	Drl	166	6	87	do.	38	do.	.5	Farm	Well not in use.
Cb 596	12Y,	9.8S,	4.3W	New York Power and Light Co.	180	Drl	300	8	20	do.	29	do.	16	Dom	Drawdown reported to be 21 feet.
Cb 598	12Y,	9.8S,	3.5W	Henry Kurzyma	190	Drl	157	6	...	Pleistocene gravel	5	Jet	10	Dom	(b)
Cb 601	12Y,	9.5S,	2.3W	Keaner Bros.	250	Drl	93	6	19	Normanskill shale	16	Force	4	Farm	Drawdown reported to be 14 feet.
Cb 602	12Y,	9.6S,	2.5W	J. Blumenthal	240	Drl	215	6	20	do.	..	None	25	Com	New well; pump not yet installed, March 25, 1946.
Cb 604	12Y,	9.7S,	2.0W	Joseph West	260	Drl	101	6	21	do.	15	Force	10	Dom	Drawdown reported to be 13 feet.
Cb 606	12Y,	10.2S,	2.3W	Stanley Augie	240	Drl	160	6	7	do.	30	do.	6	Dom	Drawdown reported to be 50 feet.

See footnotes at end of table.

Table 6.—Records of selected wells in Columbia County, New York (Continued)

Well number	Location	Owner	Altitude above sea level (feet)	Type of well	Depth (feet)	Diameter (inches)	Depth to bedrock (feet)	Geologic subdivision	Water level below land surface (feet)	Method of lift	Yield (gallons per minute)	Use	Remarks
Cb 610	12Y, 11.0S, 2.6W	Van Gunst Bros.	240	Drl	156	6	80	Normanskill shale	40	Jet	5	Farm	
Cb 612	12Y, 11.5S, 2.6W	Claire Bee	240	Drl	140	6	126	do.	36	do.	15	Dom	Drawdown reported to be 44 feet.
Cb 613	12Y, 12.1S, 2.6W	Joseph Schneider	260	Drl	100	6	40	do.	20	do.	7.5	Farm	
Cb 615	12Y, 12.9S, 2.5W	Walter Diefenbach	280	Drl	115	6	95	do.	20	Force	25	Farm	Drawdown reported to be 30 feet.
Cb 616	12Y, 13.1S, 2.6W	Twin Lakes Tavern	270	Drl	125	6	80	do.	40	do.	27	Com	Drawdown reported to be 82 feet.
Cb 617	12Y, 13.5S, 2.5W	Camp Scatico	260	Drl	180	6	40	do.	30	do.	25	Com	
Cb 619	12Y, 11.7S, 1.9W	J. D. McCusker	340	Drl	88	6	7	do.	9	do.	6	Farm	Drawdown reported to be 79 feet.
Cb 620	12Y, 10.5S, 1.5W	P. Egan	300	Drl	144	6	8	do.	25	Jet	8	Dom	
Cb 622	12Y, 8.0S, 2.0W	Anthony Cubinski	260	Drl	123	6	123	Pleistocene gravel	37	Force	25	Dom	Drawdown reported to be 13 feet after pumping for 4 hours.
Cb 624	12Y, 7.5S, 1.8W	William Keenan	200	Drl	58	6	...	do.	18	do.	.5	Dom	
Cb 628	12Y, 7.4S, 1.2W	Robert Brew	300	Drl	125	6	4	Normanskill shale	25	do.	10	Farm	Drawdown reported to be 35 feet.
Cb 630	12Y, 7.3S, 1.4W	Stanley Demkoski	220	Drl	121	6	20	do.	20	do.	1.5	Dom	Drawdown reported to be 12 feet.
Cb 632	12Y, 6.9S, 1.4W	Senn Produce Co.	240	Drl	257	6	0	do.	18	..	16	Ind	Drawdown reported to be 82 feet.
Cb 633	12Y, 6.3S, 1.0W	H. D. Stickles	240	Drl	135	6	16	do.	20	Suction	4.5	Farm	Drawdown reported to be 70 feet.
Cb 635	12Y, 5.8S, 1.8W	M. Lotter	220	Drl	86	6	11	Schodack formation	15	Force	4.2	Dom	
Cb 638	12Y, 5.6S, 0.5W	Harry Hammon	250	Drl	79	6	60	Nassau formation	27	do.	12	Farm	Drawdown reported to be 3 feet.
Cb 639	12Y, 5.9S, 0.6W	Michael Mayton	250	Drl	100	6	52	Normanskill shale	30	do.	15	Farm	Drawdown reported to be 45 feet.
Cb 640	12Y, 5.1S, 0.2W	E. A. Fitch	230	Drl	520	6	212	Nassau formation	80	do.	6	Dom	
Cb 643	12Y, 6.3S, 0.2E	W. Gerlach	280	Drl	46	6	10	do.	15	..	6	Farm	Drawdown reported to be 7 feet.
Cb 646	12Y, 6.8S, 0.4E	Harold Weaver	260	Drl	207	6	0	do.	25	Force	20	Farm	Well used by 10 families.
Cb 647	12Y, 7.6S, 0.3E	John Kulisek	350	Drl	100	6	20	Normanskill shale	10	..	2	Dom	Drawdown reported to be 90 feet.
Cb 648	12Y, 6.4S, 0.8E	W. J. Ten Broeck	300	Drl	95	6	11	do.	6	..	24	Dom	Drawdown reported to be 74 feet.
Cb 649	12Y, 6.2S, 0.9E	do.	350	Drl	333	6	96	do.	107	Force	20	Dom	Drawdown reported to be 173 feet. Well not in use, October 16, 1945.
Cb 653	12Y, 6.2S, 1.4E	R. P. Babcock	360	Drl	227	6	10	do.	18	do.	15	Farm	Drawdown reported to be 17 feet after pumping for 4 hours.
Cb 654	12Y, 7.0S, 1.4E	do.	440	Drl	235	6	10	do.	27	do.	33	Farm	Drawdown reported to be 33 feet after pumping for 4 hours.
Cb 655	12Y, 6.5S, 2.3E	Arthur Hoyle	590	Drl	122	6	11	do.	20	do.	1.5	Dom	Drawdown reported to be 30 feet.
Cb 657	12Y, 7.5S, 1.2E	Burril Buffington	280	Drl	80	6	11	do.	8	..	11	Dom	Drawdown reported to be 14 feet.
Cb 659	12Y, 6.9S, 4.0E	J. C. Davidson	640	Drl	236	6	106	do.	16	Force	4.5	Dom	Drawdown reported to be 200 feet after pumping for 4 hours.
Cb 665	12Y, 7.7S, 3.6E	Anthony Hertl	750	Drl	196	6	123	do.	40	do.	3	Farm	Drawdown reported to be 140 feet.[b]

See footnotes at end of table.

Table 6.—Records of selected wells in Columbia County, New York (Continued)

Well number	Location	Owner	Altitude above sea level (feet)	Type of well	Depth (feet)	Diameter (inches)	Depth to bedrock (feet)	Geologic subdivision	Water level below land surface (feet)	Method of lift	Yield (gallons per minute)	Use	Remarks
Cb 667	12Y, 7.7S, 3.0E	Eugene Galant	730	Drl	138	6	7	Normanskill shale	35	Force	5.5	Dom	Drawdown reported to be 95 feet after pumping for 4 hours.
Cb 668	12Y, 8.3S, 0.6E	Parl Durocher	460	Drl	109	6	41	do.	25	do.	6	Farm	Drawdown reported to be 12 feet after pumping for 4 hours.
Cb 669	12Y, 8.6S, 1.4E	M. Houghtaling	320	Drl	60	6	45	do.	8	..	6	Dom	Drawdown reported to be 20 feet.
Cb 672	12Y, 10.5S, 1.5E	M. Wheeler	700	Drl	128	6	4	Nassau formation	30	Force	3.5	Dom	Drawdown reported to be 70 feet.
Cb 673	12Y, 9.4S, 2.2E	S. Pulaski	400	Drl	286	6	...	Normanskill shale	60	Jet	6	Farm	
Cb 679	12Y, 8.7S, 6.9E	M. McNalley	600	Drl	75	6	20	do.	2	do.	4	Dom	Drawdown reported to be 20 feet.
Cb 680	12Y, 8.7S, 5.2E	Harry Post	620	Drl	120	6	24	do.	8	Force	3	Farm	Drawdown reported to be 67 feet after pumping for 4 hours.
Cb 682	12Y, 8.3S, 4.4E	Dr. E. Buxbaum	620	Drl	450	6	240	do.	250	do.	2	Dom	([b])
Cb 685	12Y, 8.1S, 6.7E	Arthur Coleman	590	Drl	107	6	6	do.	10	do.	8	Dom	Drawdown reported to be 90 feet.
Cb 686	12Y, 6.3S, 4.8E	Peter Hammer	830	Drl	60	6	6	do.	9	do.	1.5	Dom	Drawdown reported to be 19 feet.
Cb 687	12Y, 5.1S, 5.7E	Miotte Mortgefolgio	800	Drl	60	6	6	do.	6	do.	10.5	Dom	
Cb 689	12Y, 5.8S, 7.2E	Christiano Brothers	630	Drl	110	6	62	do.	15	do.	5	Farm	
Cb 697	12Y, 7.2S, 12.1E	Earl Shattuck	720	Drl	97	6	16	Stockbridge limestone	38	do.	6	Dom	Drawdown reported to be 42 feet.[b]
Cb 698	12Y, 7.1S, 12.5E	W. Harry Black	900	Drl	123	6	123	Pleistocene sand	37	do.	.5	Dom	Drawdown reported to be 53 feet.[b]
Cb 700	12Y, 7.3S, 11.7E	S. E. Pearse	600	Drl	137	4½	...	do.	40	do.	3	Dom	Finished with screen.
Cb 701	12Y, 6.5S, 11.1E	Rolf Felts	690	Drl	122	6	14	Normanskill shale	15	..	2.5	Dom	Drawdown reported to be 60 feet.
Cb 706	12Y, 6.5S, 9.1E	M. French	750	Drl	95	6	20	do.	15	..	.5	Dom	Drawdown reported to be 35 feet.
Cb 708	12Y, 6.1S, 9.5E	Daniel Connelly	790	Drl	61	6	11	do.	18	..	2	Farm	Drawdown reported to be 43 feet.
Cb 709	12Y, 6.1S, 8.8E	J. Giannattesio	670	Drv	11	1¼	...	Pleistocene gravel	7	Suction	3	Dom	
Cb 710	12Y, 6.7S, 8.4E	Leroy Van de Carr	800	Drl	121	..	0	Normanskill shale	16	Force	100	PWS	Temperature 45° F., April 1947.
Cb 712	12Y, 6.9S, 8.1E	M. Orbach	740	Drl	205	6	18	do.	10	..	9	Dom	Drawdown reported to be 130 feet.
Cb 715	12Y, 7.4S, 8.5E	Lake View Cottage Owners Assoc.	850	Drl	134	6	2	do.	..	Force	8	PWS	Auxiliary well.
Cb 716	12Y, 7.4S, 8.5E	do.	850	Drl	200	8	2	do.	19	do.	12	PWS	Average pumpage 4,000 gallons per day.
Cb 719	12Y, 7.8S, 8.5E	George Portens	720	Drl	130	6	4	do.	30	do.	.1	Dom	
Cb 722	12Y, 8.7S, 8.0E	M. A. Kuhn	740	Drl	211	6	60	do.	37	do.	1.5	Dom	
Cb 723	12Y, 9.5S, 8.1E	I. Simmons	730	Drl	80	6	10	do.	15	Suction	5	Farm	
Cb 724	12Y, 9.9S, 7.2E	George Rover	600	Drl	75	6	25	do.	20	Force	10	Dom	
Cb 725	12Y, 10.3S, 8.3E	Dr. Raab	580	Drl	89	6	36	do.	17	do.	15	Farm	
Cb 733	12Y, 9.9S, 10.5E	J. Gabascia	550	Drl	56	6	...	Pleistocene gravel	7	..	5	Dom	Data from U. S. Geol. Survey Water-Supply Paper 102, p. 179.[b]

See footnotes at end of table.

Table 6.—Records of selected wells in Columbia County, New York (Continued)

Well number	Location	Owner	Altitude above sea level (feet)	Type of well	Depth (feet)	Diameter (inches)	Depth to bedrock (feet)	Geologic subdivision	Water level below land surface (feet)	Method of lift	Yield (gallons per minute)	Use	Remarks
Cb 736	12Y, 9.2S, 10.5E	Bronx Valley Council Boy Scouts	540	Drl	83	8	83	Pleistocene sand	8	Suction	5	Dom	
Cb 737	12Y, 8.9S, 11.6E	E. Weaver	640	Drl	68	6	44	Stockbridge limestone	20	do.	20	Dom	Rock very hard—driller could make only 3 feet per day.[a]
Cb 741	12Y, 13.7S, 11.9E	L. Parry	780	Drl	204	6	178	do.	..	Force	4	Dom	[b]
Cb 742	12Y, 16.0S, 11.2E	J. J. Calalarco	1,040	Drl	216	6	100	Normanskill shale	40	Jet	8	Dom	
Cb 744	12Y, 14.9S, 9.5E	Arnold Rothvoss	590	Drl	150	6	75	Stockbridge limestone	10	Force	..	Farm	
Cb 747	12Y, 16.5S, 7.5E	Clara Atzenbeck	560	Drl	176	6	4	Normanskill shale	..	do.	..	Dom	
Cb 749	12Y, 15.0S, 7.1E	H. Miller	580	Drl	90	6	58	Stockbridge limestone	56	do.	3	Farm	Drawdown reported to be 24 feet.
Cb 750	12Y, 14.2S, 6.9E	M. J. Bryant	560	Drl	62	6	22	do.	25	do.	20	Farm	
Cb 751	12Y, 14.3S, 8.2E	H. L. O'Brien	700	Drl	323	6	19	do.	58	do.	1.5	Farm	
Cb 753	12Y, 13.3S, 9.8E	W. E. Blodgett	540	Drl	163	6	4	do.	8	do.	..	Farm	
Cb 760	12Y, 12.5S, 5.5E	M. Stubenger	650	Drl	166	6	20	Normanskill shale	20	do.	5	Dom	Drawdown reported to be 31 feet.
Cb 770	12Y, 15.4S, 5.6E	Peter Hall	660	Drl	96	6	20	do.	20	Suction	1.5	Dom	Drawdown reported to be 10 feet.
Cb 771	12Y, 16.5S, 5.6E	Perry Mellius	810	Drl	66	6	4	do.	19	..	10	Dom	Drawdown reported to be 21 feet.
Cb 772	12Y, 16.4S, 4.4E	Thomas Healey	590	Drl	100	6	12	do.	15	Force	3	Dom	Drawdown reported to be 25 feet.
Cb 775	12Y, 15.2S, 4.3E	William O'Brien	500	Drl	320	6	20	do.	150	do.	2.5	Farm	
Cb 776	12Y, 14.8S, 3.9E	Crystal Brook Farm	420	Drl	100	6	48	do.	12	do.	7.5	Farm	Drawdown reported to be 78 feet.
Cb 777	12Y, 13.6S, 3.7E	Robert Ryerson	780	Drl	275	6	0	do.	19	do.	4	Dom	Drawdown reported to be 161 feet.
Cb 779	12Y, 11.7S, 5.0E	J. F. Townley	880	Drl	97	6	4	do.	40	do.	7.5	Dom	
Cb 780	12Y, 11.3S, 3.7E	Gallatin School District No. 5	600	Drl	162	6	140	do.	6	do.	10	Dom	
Cb 781	12Y, 12.2S, 3.4E	E. Cavalar	700	Drl	230	6	24	do.	20	Suction	3	Dom	
Cb 785	12Y, 14.6S, 2.7E	W. J. Knickerbocker	540	Drl	75	6	15	do.	10	do.	3.8	Dom	Drawdown reported to be 17 feet.
Cb 786	12Y, 15.0S, 2.8E	M. Shelly	520	Drl	79	6	48	do.	18	..	7.5	Farm	Drawdown reported to be 42 feet.
Cb 788	12Y, 16.0S, 2.1E	Ernest Feuss	460	Drl	110	6	10	do.	10	Jet	10	Farm	
Cb 789	12Y, 15.9S, 1.6E	Fred Zuffel	550	Drl	80	6	5	do.	20	Force	10	Dom	
Cb 791	12Y, 12.0S, 0.1E	Walter Karwacki	480	Drl	61	6	49	Nassau formation	..	Suction	16	Farm	Flowing well; flows 3 gallons per minute. Drawdown reported to be 10 feet when pumped for 4 hours.
Cb 792	12Y, 11.7S, 0.8E	Alec Krupa	520	Drl	95	6	10	do.	14	..	7	Farm	Drawdown reported to be 50 feet. Water reported to contain hydrogen sulfide.
Cb 793	12Y, 11.5S, 0.7E	John Hull	620	Drl	113	6	9	do.	15	None	6	Dom	Drawdown reported to be 98 feet. Pump not installed as of October 16, 1945.
Cb 794	12Y, 11.7S, 1.8E	M. Fix	660	Drl	94	6	3	do.	20	Force	3	Dom	Drawdown reported to be 40 feet.
Cb 796	12Y, 11.5S, 1.8E	L. Wegman	670	Drl	53	6	11	do.	7	Suction	3.8	Farm	Drawdown reported to be 17 feet.

See footnotes at end of table.

Table 6.—Records of selected wells in Columbia County, New York (Continued)

Well number	Location	Owner	Altitude above sea level (feet)	Type of well	Depth (feet)	Diameter (inches)	Depth to bedrock (feet)	Geologic subdivision	Water level below land surface (feet)	Method of lift	Yield (gallons per minute)	Use	Remarks
Cb 797	12Y, 11.0S, 1.6E	M. Aquellac	660	Drl	72	6	3	Nassau formation	..	..	1	Dom	Flowing well. Drawdown reported to be 40 feet when pumped at 1 gallon per minute.
Cb 799	12Y, 10.8S, 1.8E	George Graf	680	Drl	149	6	38	do.	6	Force	7	Dom	
Cb 802	12Y, 10.6S, 0.2W	E. Benton	500	Drl	40	6	8	do.	5	Suction	12	Farm	Drawdown reported to be 32 feet.
Cb 803	12Y, 10.9S, 0.9W	Alfred Marty	380	Drl	224	6	20	Normanskill shale	+8	Force	9	Farm	Flowing well. Drawdown reported to be 108 feet when pumped at 9 gallons per minute.
Cb 804	12Y, 11.2S, 0.4W	William Willis	460	Drl	156	6	89	do.	24	do.	10	Farm	Drawdown reported to be 36 feet.
Cb 805	12Y, 11.7S, 0.8W	H. Moskaluk	560	Drl	83	6	10	do.	18	..	25	Farm	Drawdown reported to be 65 feet.
Cb 810	12Y, 12.9S, 1.6W	W. H. Coon	480	Drl	100	6	6	Nassau formation	15	Force	2	Dom	Drawdown reported to be 45 feet.
Cb 813	12Y, 13.0S, 1.5W	H. Coon	440	Drl	68	6	2	do.	10	do.	3.2	Dom	Drawdown reported to be 50 feet.
Cb 814	12Y, 15.7S, 0.2W	John Juhring	340	Drl	94	6	15	do.	16	do.	4	Dom	
Cb 816	12Y, 14.8S, 1.3W	George Hempseed	280	Drl	121	6	41	do.	28	do.	20	Dom	Drawdown reported to be 22 feet.
Cb 817	12Y, 14.6S, 1.3W	Hugo Peters	310	Drl	150	..	0	do.	12	do.	12	Dom	Drawdown reported to be 68 feet. Temperature 54° F., October 1945.[a]
Cb 818	12Y, 14.2S, 1.4W	H. Firsching	300	Drl	56	6	16	do.	5	do.	50	Farm	
Cb 820	12Y, 13.3S, 2.1W	E. Peterson	300	Drl	110	6	15	do.	30	do.	5	Dom	Drawdown reported to be 50 feet.
Cb 821	12Y, 13.4S, 2.2W	Fred Petersen	300	Drl	115	6	12	do.	15	do.	9	Dom	Drawdown reported to be 35 feet.
Cb 823	12Y, 13.1S, 3.8W	K. C. Verro	260	Drl	75	6	5	Normanskill shale	12	do.	35	Farm	Drawdown reported to be 33 feet.
Cb 824	12Y, 12.6S, 4.0W	E. Wynn	290	Drl	143	6	15	do.	20	do.	12	Dom	Drawdown reported to be 55 feet.
Cb 825	12Y, 12.9S, 4.3W	A. L. Fuchs	240	Drl	113	6	13	do.	22	do.	4	Farm	Drawdown reported to be 18 feet.
Cb 826	12Y, 13.1S, 5.0W	J. K. Brodee	220	Drl	90	6	10	do.	14	..	8	Farm	Drawdown reported to be 25 feet.
Cb 827	12Y, 12.6S, 4.7W	W. Schmidt	220	Drl	108	6	17	do.	9	Suction	18	Com	
Cb 828	12Y, 12.0S, 4.5W	Frank Callentino	220	Drl	70	6	10	do.	18	..	5	Dom	Drawdown reported to be 42 feet.
Cb 829	12Y, 11.9S, 3.9W	F. H. Eldridge	260	Drl	148	6	0	do.	28	Force	25	Farm	Drawdown reported to be 32 feet.
Cb 830	12Y, 11.9S, 3.9W	Frank Eldridge	260	Drl	125	6	0	do.	18	do.	12	Dom	Drawdown reported to be 27 feet.
Cb 832	12Y, 10.6S, 3.9W	Clermont Fruit Packers	240	Drl	240	6	9	do.	5	..	20	Ind	Drawdown reported to be 145 feet. Average pumpage 9,600 gallons per day, September through November.
Cb 835	12Y, 9.3S, 5.1W	M. W. Brush	220	Drl	110	6	5	Schodack formation	15	Force	5	Dom	Drawdown reported to be 55 feet.
Cb 836	12Y, 11.3S, 4.7W	Luther Smith	260	Drl	90	6	7	Normanskill shale	15	do.	1.8	Dom	
Cb 837	12Y, 11.2S, 5.0W	Henry Steeneck	240	Drl	108	6	0	do.	14	..	3	Farm	Drawdown reported to be 16 feet.
Cb 840	12Y, 11.8S, 6.1W	Wetzel Werner	220	Drl	80	6	4	do.	18	Force	4	Dom	
Cb 841	12Y, 12.1S, 5.4W	Clermont Farms	200	Drl	96	6	12	do.	15	do.	15	Farm	Drawdown reported to be 50 feet.
Cb 842	12Y, 11.5S, 6.6W	Harold Rockefeller	190	Drl	115	6	20	do.	7	..	2	Farm	Drawdown reported to be 23 feet.

See footnotes at end of table.

Table 6.—Records of selected wells in Columbia County, New York (Concluded)

Well number	Location	Owner	Altitude above sea level (feet)	Type of well	Depth (feet)	Diameter (inches)	Depth to bedrock (feet)	Geologic subdivision	Water level below land surface (feet)	Method of lift	Yield (gallons per minute)	Use	Remarks
Cb 845	12Y, 11.1S, 7.7W	Henry Bahr	160	Drl	105	6	22	Normanskill shale	15	..	3	Farm	Drawdown reported to be 75 feet.
Cb 847	12Y, 10.9S, 8.3W	Fred Cottrel	160	Drl	210	6	...	do.	8	Suction	7	Dom	Water reported to contain hydrogen sulfide.
Cb 850	12Y, 11.0S, 8.6E	J. L. Freeborn	160	Drl	156	6	48	do.	20	Force	15	Dom	
Cb 852	12Y, 0.2N, 2.8W	Atlas Cement Co.	8	Drl	1,008	6	110	do.	..	None	5	Ind	Well never used because salt water was obtained.[b]
Cb 854	12Y, 0.6N, 2.7W	Hudson Glue Factory	10	Drl	26	10	...	Pleistocene sand and gravel	8	..	300	Ind	Average pumpage 156,000 gallons per day.
Cb 855	11Y, 7.1S, 3.1E	Village of Kinderhook	200	Drl	35	6	...	Recent gravel	18	None	110	PWS	New well; pump not installed as of October 14, 1947. Finished with 6 feet of 6-inch screen. Drawdown, 1.5 feet after pumping 8 hours.
Cb 856	11Y, 7.1S, 3.1E	do.	200	Drl	32	8	...	do.	17	Force	220	PWS	New well; pump not installed as of October 18, 1947. Finished with 6 feet of 8-inch screen and 2 feet of gravel packing. Drawdown, 7.5 feet after pumping 6 hours. Temperature 52° F., October 1947.
Cb 857	12Y, 2.8S, 1.6W	J. B. Draffin	220	Drl	50	6	10	Coeymans limestone	..	Jet	..	Dom	Temperature 51° F., November 1947.[a]
Cb 858	12Y, 1.0S, 1.1W	A. Colarusso & Son	280	Drl	118	6	0	New Scotland limestone	..	Force	10	Ind	Temperature 50° F., November 1947.[a]
Cb 859	11Y, 4.3S, 9.1E	C Benedict	470	Drl	300	6	90	Nassau formation	100	Jet	8	Farm	
Cb 860	12Y, 7.9S, 3.8W	Carl Salibeni	180	Drl	305	6	38	Normanskill shale	20	Force	6	Dom	Temperature 57° F., September 1947.[a]
Cb 862	11Y, 6.4S, 3.3E	Village of Valatie	210	Drl	52	8	52	Recent sand	12	Suction	100	PWS	Finished with 5 feet of 6-inch screen.
Cb 865	11Y, 6.4S, 3.3E	do.	210	Dug	20	48	...	do.	13	do.	100	PWS	Fourteen-inch, fifty-feet long tile pipe laid in crushed stone, extends horizontally from bottom of well.[a]
Cb 868	11Y, 16.7S, 5.7E	Eric Seaman	480	Drl	107	6	7	Normanskill shale	10	..	5	Dom	Drawdown reported to be 50 feet.
Cb 869	11Y, 6.4S, 3.3E	Village of Valatie	210	Drl	50	8	50	Recent sand	12	Suction	75	PWS	Finished with 5 feet of 8-inch screen.
Cb 870	11Y, 6.4S, 3.3E	do.	210	Drl	35	8	...	do.	12	do.	150	PWS	Do.

[a] For chemical analysis see table 4.
[b] For well log see table 5.

Table 7.—Reports dealing with ground-water conditions in New York, prepared by the U. S. Geological Survey and the New York State Water Power and Control Commission in cooperation with various counties and municipalities and published by the Commission[a]

Bulletin GW	Title	Author(s)	Year published
1	Withdrawal of ground water on Long Island, N. Y.	Thompson, D. G. and Leggette, R. M.	1936
2	Engineering report on the water supplies of Long Island.	Suter, Russell	1937
3	Record of wells in Kings County, N. Y.	Leggette, R. M. and others	1937
4	Record of wells in Suffolk County, N. Y.	Leggette, R. M. and others	1938
5	Record of wells in Nassau County, N. Y.	Leggette, R. M. and others	1938
6	Record of wells in Queens County, N. Y.	Leggette, R. M. and others	1938
7	Report on the geology and hydrology of Kings and Queens Counties, Long Island.	Sanford, Homer	1938
8	Record of wells in Kings County, N. Y.	Leggette, R. M. and Brashears, M. L., Jr.	1944
9	Record of wells in Suffolk County, N. Y., supplement I.	Roberts, C. M. and Brashears, M. L., Jr.	1945
10	Record of wells in Nassau County, N. Y., supplement I.	Roberts, C. M. and Brashears, M. L., Jr.	1946
11	Record of wells in Queens County, N. Y., supplement I.	Roberts, C. M. and Jester, Marion C.	1947
12	The water table in the western and central parts of Long Island, N. Y.	Jacob, C. E.	1945
13	The configuration of the rock floor in western Long Island, N. Y.	De Laguna, Wallace and Brashears, M. L., Jr.	1948
14	Correlation of ground-water levels and precipitation on Long Island, N. Y.	Jacob, C. E.	1945
15	Progress report on ground-water resources of the southwestern part of Broome County, N. Y.	Brown, R. H. and Ferris, J. G.	1946
16	Progress report on ground-water conditions in the Cortland quadrangle, N. Y.	Asselstine, E. S.	1946
17	Geologic correlation of logs of wells in Kings County, N. Y.	De Laguna, Wallace	1948
18	Mapping of geologic formations and aquifers of Long Island, N. Y.	Suter, Russell; De Laguna, Wallace and Perlmutter, N. M.	1950
19	Geologic atlas of Long Island.	......	1950
20	The ground-water resources of Albany County, N. Y.	Arnow, Theodore	1949
21	The ground-water resources of Rensselaer County, N. Y.	Cushman, R. V.	1950
22	The ground-water resources of Schoharie County, N. Y.	Berdan, Jean M.	1950
23	The ground-water resources of Montgomery County, N. Y.	Jeffords, R. M.	1950
24	The ground-water resources of Fulton County, N. Y.	Arnow, Theodore	1950

[a] Records of periodic measurement of the position of the water level in observation wells in New York are printed annually in the water-supply papers of the U. S. Geological Survey. See Water-Supply Papers 777, 817, 840, 845, 886, 906, 936, 944, 986, 1016, 1023, and 1071.

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